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# REPORT

OF THE

# TESTS OF METALS

AND

# OTHER MATERIALS

MADE WITH THE

UNITED STATES TESTING MACHINE AT WATERTOWN ARSENAL, MASSACHUSETTS, DURING THE FISCAL YEAR ENDED JUNE 30

## 1912

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## LETTER OF TRANSMITTAL.

WAR DEPARTMENT,
*Washington, March 3, 1913.*

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

SIR: I have the honor to transmit, herewith, a letter from the Acting Chief of Ordnance, United States Army, of this date, submitting, for transmission to Congress as required by law, copy of the report of the commanding officer of Watertown Arsenal, of "Tests of iron and steel and other materials for industrial purposes," made at that arsenal during the fiscal year ended June 30, 1912.

Very respectfully,

HENRY L. STIMSON,
*Secretary of War.*

## LETTER OF SUBMITTAL.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ORDNANCE,
*Washington, March 3, 1913.*

From: The Acting Chief of Ordnance.
To: The Secretary of War.
Subject: Annual report, tests of iron, steel, etc., 1912.

I submit herewith, for transmission to Congress as required by law, a copy of the report of the commanding officer of Watertown Arsenal, of "Tests of iron and steel and other materials for industrial purposes," made at that arsenal during the fiscal year ended June 30, 1912.

R. BIRNIE.

WATERTOWN ARSENAL,
*Watertown, Mass., August 16, 1912.*

From: The Commanding Officer, Watertown Arsenal.
To: The Chief of Ordnance.
Subject: Annual report tests iron, steel, etc.

SIR: 1. I have the honor to submit herewith the annual report of tests of iron, steel, and other materials made at this arsenal during the fiscal year ending June 30, 1912.

2. The total number of specimens tested during the year was 3,143, classified as follows:

| | |
|---|---|
| Gun specimens | 37 |
| For Ordnance Department | 2,566 |
| For other Government departments | 25 |
| Tests for private parties | 515 |
| Total | 3,143 |

The receipts and expenditures were as follows:

| | |
|---|---|
| Amount appropriated for testing machine and testing work | $15,000.00 |
| Received for private tests | 964.33 |
| Total received | 15,964.33 |
| Amount expended for service and labor | 12,072.11 |
| Amount expended for light, power, tools, implements, and material for tests | 3,892.22 |
| Total expended | 15,964.33 |

3. The equipment of the laboratory has been increased by the purchase of two Ewing extensometers, one for 2-inch gauge lengths and one for 8-inch gauge lengths, with the necessary laying-off gauges; an apparatus for making either single or double shearing tests of metals; an Edelmann thermo-electric apparatus for determining the elastic limit of metals; and a Baloptican projection lantern. The Shore scleroscope has been modified to make it of the latest design.

4. Tests to determine the relative wearing qualities of bronzes have been continued, and it is hoped that definite data may soon be submitted.

5. A large number of tests on square steel wire for winding guns have been completed and data of value has been obtained. The Ordnance Department specifications for this material have been changed, as a result of these tests, so as to make them more definite and less dependent upon the personal equation of the inspector.

6. A number of reports on the metallographic examination of specimens, made by Dr. Henry Fay, of the Massachusetts Institute of Technology, are included in this report.

Respectfully,
C. B. WHEELER,
*Lieutenant Colonel, Ordnance Department,*
*United States Army, Commanding.*

CHIEF OF ORDNANCE, UNITED STATES ARMY,
*Washington, D. C.*

# TABLE OF CONTENTS.


| | | Page. |
|---|---|---|
| 1. | Square steel wire | 11 |
| 2. | Ordnance specimens | 45 |
| 3. | Column program | 85 |
| 4. | Springs for ordnance work | 107 |
| 5. | Steel castings for ordnance work | 125 |
| 6. | Steel forgings for ordnance work | 143 |
| 7. | Bronze for ordnance work | 157 |
| 8. | Cast iron for ordnance work | 165 |
| 9. | Gun and tool steel for ordnance work | 169 |
| 10. | Proof test of piston rods and chain for ordnance work | 171 |
| 11. | Miscellaneous tests for ordnance work | 175 |
| 12. | Hollow-deck stanchions | 181 |
| 13. | Steel specimens for comparison of testing machines | 183 |
| 14. | Cordage, manila rope, steel wire rope | 195 |
| 15. | Metallographic examinations | 219 |
| 16. | Rubber | 223 |
| 17. | Gun casting | 227 |
| 18. | Blue and brown print paper | 233 |
| 19. | Anchor bolts | 237 |
| 20. | Miscellaneous tests of steel castings | 239 |
| 21. | Private tests | 243 |

# REPORT

OF THE

# TESTS OF METALS

AND

# OTHER MATERIALS

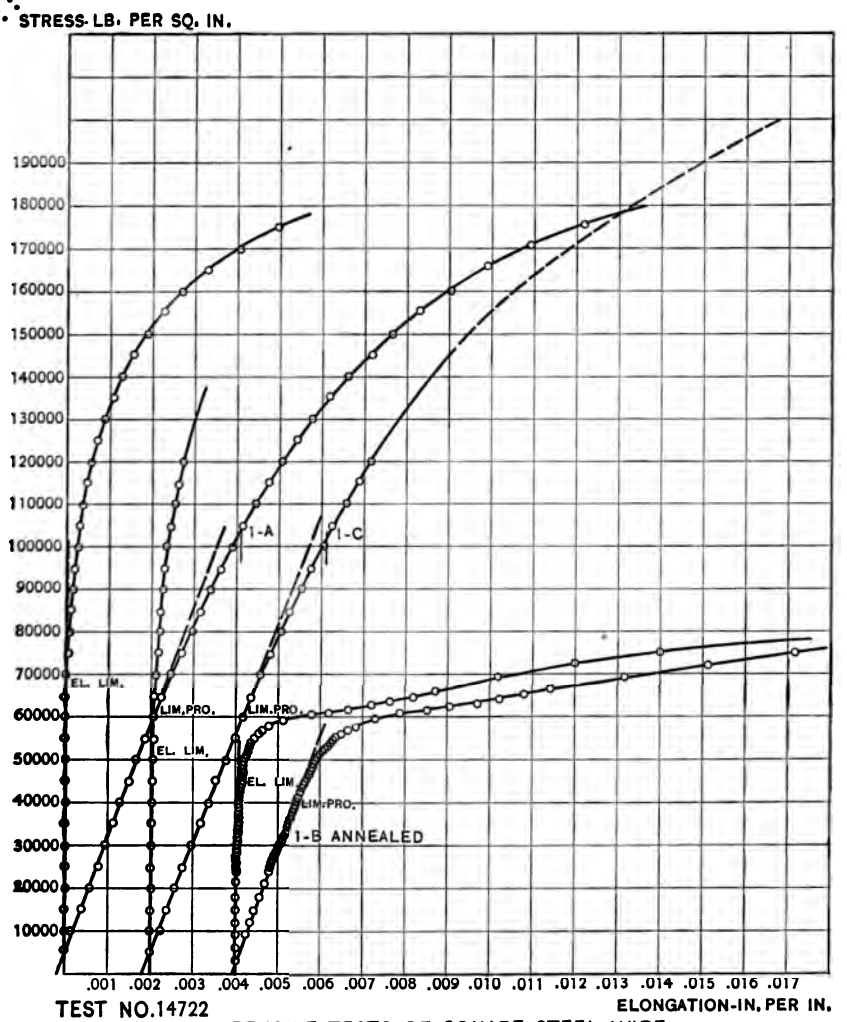
MADE WITH THE

UNITED STATES TESTING MACHINE AT WATERTOWN ARSENAL, MASSACHUSETTS, DURING THE FISCAL YEAR ENDED JUNE 30, 1912.

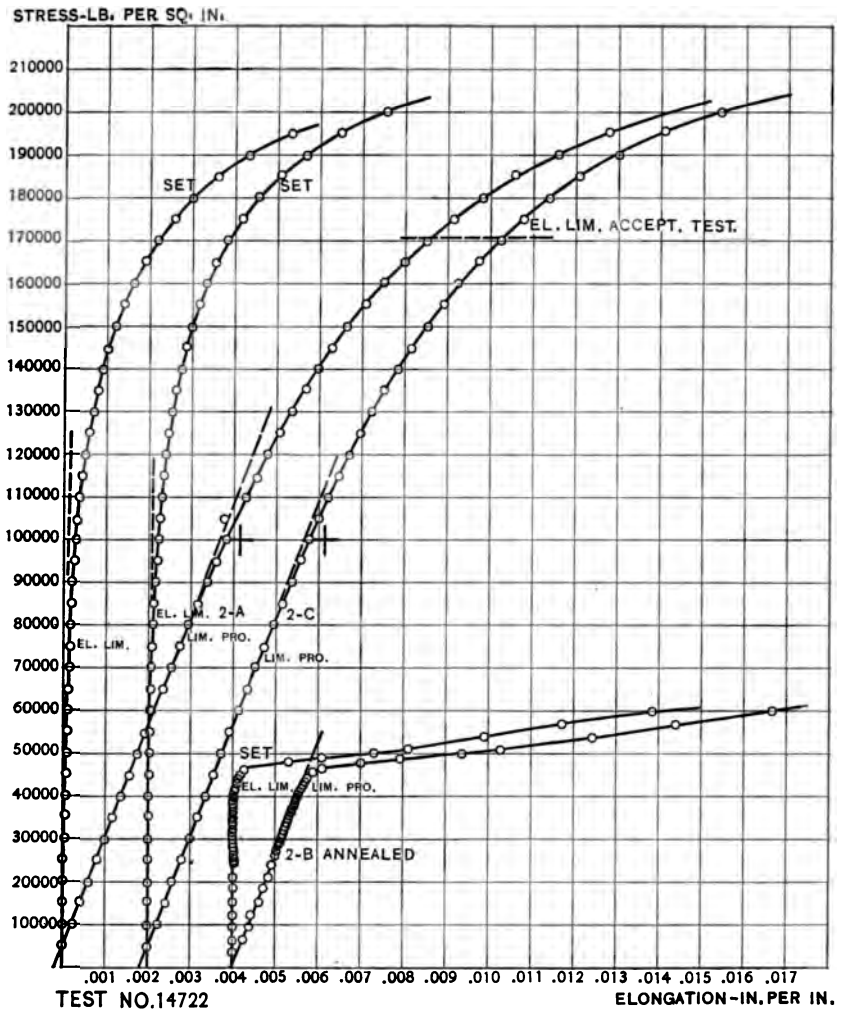
# SQUARE STEEL WIRE FOR WINDING GUNS.

## TENSILE TESTS TO DETERMINE THE ELASTIC LIMIT.

NOTE.—Test 14722 is continued from "Tests of Metals, etc., 1911." Curves 1–A, 1–B, 1–C, 2–A, 2–B, 2–C, and 3–A are plotted from data tabulated therein.




TENSILE TESTS OF SQUARE STEEL WIRE
FOR WINDING GUNS.
DETERMINATION OF ELASTIC LIMIT.




TENSILE TESTS OF SQUARE STEEL WIRE
FOR WINDING GUNS.
DETERMINATION OF ELASTIC LIMIT.

## TEST 14722.

From same coil as 3–A or Sample No. 3.

This sample was annealed at 1,500° F. for 1 hour and allowed to cool slowly in furnace for about 9 hours; annealed the second time at 1,500° F. for 3 hours and allowed to cool in furnace for about 9 hours.

Marks: 3–B.

Dimensions, 0.1267 by 0.1270 in.

Sectional area, 0.01609 sq. in.

Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 80 | 4,970 | .0 | 0. | 0. | 0. | |
| 159 | 9,880 | .0059 | 0. | .00020 | 0. | |
| 239 | 14,850 | .0111 | .0001 | .00037 | 0. | |
| 319 | 19,830 | .0170 | .0004 | .00057 | .00001 | |
| 398 | 24,740 | .0225 | .0008 | .00075 | .00003 | |
| 478 | 29,710 | .0291 | .0010 | .00097 | .00003 | |
| 558 | 34,680 | .0360 | .0023 | .00120 | .00008 | |
| 573 | 35,620 | .0372 | .0028 | .00124 | .00009 | |
| 589 | 36,610 | .0388 | .0030 | .00129 | .00010 | |
| 605 | 37,600 | .0402 | .0037 | .00134 | .00012 | |
| 621 | 38,600 | .0413 | .0040 | .00138 | .00013 | |
| 637 | 39,590 | .0453 | .0068 | .00151 | .00023 | |
| 653 | 40,590 | .0490 | .0097 | .00163 | .00032 | |
| 669 | 41,580 | .0720 | .0301 | .00240 | .00100 | |
| 685 | 42,580 | .1210 | .0760 | .00403 | .00253 | |
| 701 | 43,570 | .1690 | .1208 | .00563 | .00403 | |
| 717 | 44,560 | .1808 | .1395 | .00603 | .00465 | |
| 733 | 45,560 | .2070 | .1560 | .00690 | .00520 | |
| 749 | 46,550 | .2290 | .1760 | .00763 | .00587 | |
| 765 | 47,550 | .2520 | .1957 | .00840 | .00652 | |
| 781 | 48,540 | .2752 | .2175 | .00917 | .00725 | |
| 797 | 49,540 | .2965 | .2363 | .00988 | .00788 | |
| 812 | 50,470 | .3205 | .2590 | .01068 | .00863 | |
| 828 | 51,460 | .3410 | .2774 | .01137 | .00924 | |
| 844 | 52,460 | .3644 | .2991 | .01215 | .00997 | |
| 860 | 53,450 | .3857 | .3188 | .01286 | .01063 | |
| 1,380 | 85,770 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 2.50 in. in 30 in. = 8.3 per cent.

Dimensions at fracture, 0.111 by 0.111 in. Sectional area, 0.01232 sq. in.

Contraction of area, 22.6 per cent.

Position of fracture, 1.40 in. outside gauge marks.

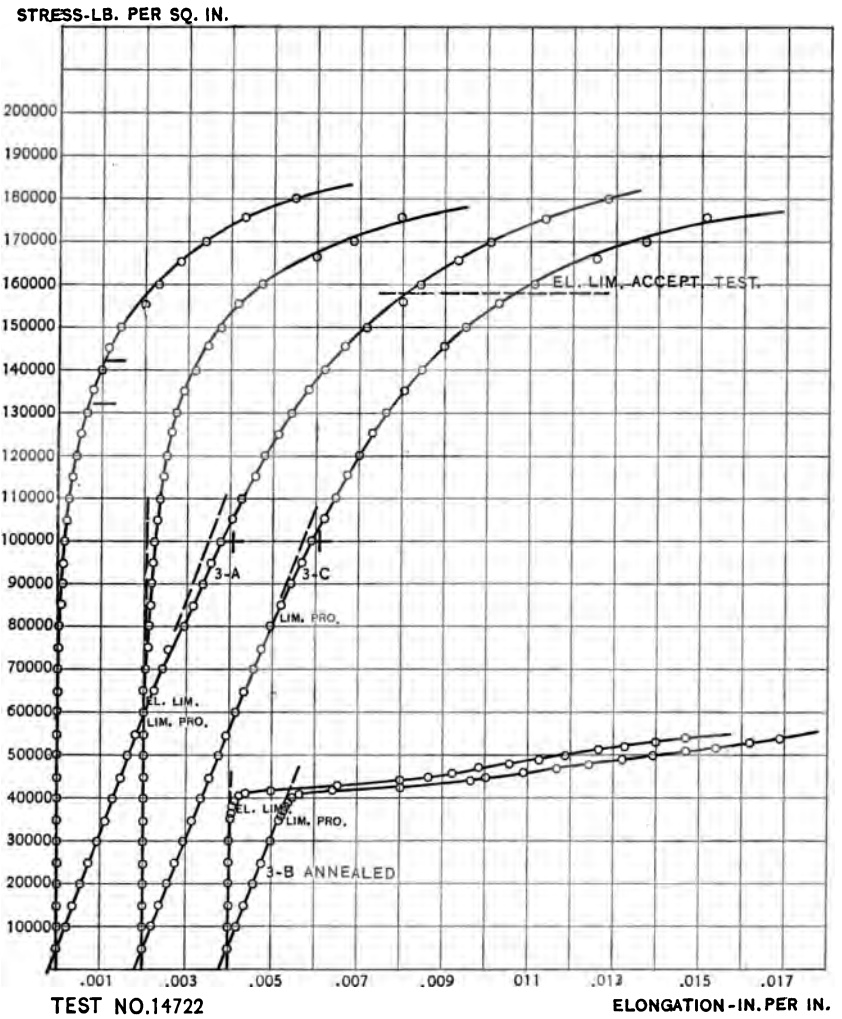
Appearance of fracture, Silky.

## *SQUARE STEEL WIRE FOR WINDING GUNS.*

From same coil as 3–A or sample No. 3.
Marks, 3–C.
Dimensions, 0.1257 by 0.1267 in.
Sectional area, 0.01592 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 80 | 5,000 | 0. | 0. | 0. | 0. | |
| 159 | 10,000 | .0057 | .0002 | .00019 | .00001 | |
| 239 | 15,000 | .0112 | 0. | .00037 | 0. | |
| 319 | 20,000 | .0170 | .0002 | .00057 | .00001 | |
| 398 | 25,000 | .0230 | .0001 | .00077 | 0. | |
| 478 | 30,000 | .0283 | .0004 | .00094 | .00001 | |
| 558 | 35,000 | .0342 | .0005 | .00114 | .00002 | |
| 637 | 40,000 | .0402 | .0002 | .00134 | .00001 | |
| 717 | 45,000 | .0458 | .0010 | .00153 | .00003 | |
| 797 | 50,000 | .0520 | .0010 | .00173 | .00003 | |
| 876 | 55,000 | .0582 | .0013 | .00194 | .00004 | |
| 956 | 60,000 | .0648 | .0019 | .00216 | .00006 | |
| 1,035 | 65,000 | .0703 | .0021 | .00234 | .00007 | |
| 1,115 | 70,000 | .0768 | .0024 | .00256 | .00008 | |
| 1,195 | 75,000 | .0825 | .0032 | .00275 | .00011 | |
| 1,274 | 80,000 | .0892 | .0031 | .00297 | .00010 | |
| 1,354 | 85,000 | .0960 | .0046 | .00320 | .00015 | |
| 1,434 | 90,000 | .1030 | .0055 | .00343 | .00018 | |
| 1,513 | 95,000 | .1108 | .0070 | .00369 | .00023 | |
| 1,593 | 100,000 | .1171 | .0080 | .00390 | .00027 | |
| 1,673 | 105,000 | .1260 | .0093 | .00420 | .00031 | |
| 1,752 | 110,000 | .1331 | .0119 | .00444 | .00040 | |
| 1,832 | 115,000 | .1420 | .0140 | .00473 | .00047 | |
| 1,912 | 120,000 | .1509 | .0162 | .00503 | .00054 | |
| 1,991 | 125,000 | .1594 | .0190 | .00531 | .00063 | |
| 2,071 | 130,000 | .1699 | .0228 | .00566 | .00076 | |
| 2,151 | 135,000 | .1818 | .0280 | .00606 | .00093 | |
| 2,230 | 140,000 | .1941 | .0340 | .00647 | .00113 | |
| 2,310 | 145,000 | .2098 | .0421 | .00699 | .00140 | |
| 2,390 | 150,000 | .2260 | .0522 | .00753 | .00174 | |
| 2,469 | 155,000 | .2470 | .0657 | .00823 | .00219 | |
| 2,549 | 160,000 | .2719 | .0825 | .00906 | .00275 | |
| 2,628 | 165,000 | .3190 | .1210 | 01063 | .00403 | |
| 2,708 | 170,000 | .3510 | .1462 | .01170 | .00487 | |
| 2,788 | 175,000 | .3910 | .1790 | .01303 | .00597 | |
| 3,120 | 196,000 | ..... | ..... | ..... | ..... | =Tensile strength. |

Elongation after fracture, 0.68 in. in 30 in. = 22.7 per cent.
Dimensions at fracture, 0.093 by 0.093 in.
Sectional area, 0.00865 sq. in. Contraction of area, 45.6 per cent.
Position of fracture, 2.35 in. inside gauge marks.
Appearance of fracture, silky.




TENSILE TESTS OF SQUARE STEEL WIRE
FOR WINDING GUNS.
DETERMINATION OF ELASTIC LIMIT.

Sample No. 4. Reel 918. P. O. 8320. Diameter of coil in natural state: 26 in.
Marks, 4–A.
Dimensions, 0.1265 by 0.1269 in.
Sectional area, 0.01605 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 80 | 5,000 | 0. | 0. | 0. | 0. | |
| 160 | 10,000 | .0053 | 0. | .00018 | 0. | |
| 240 | 15,000 | .0111 | −.0002 | .00037 | −.00001 | |
| 321 | 20,000 | .0166 | 0. | .00055 | 0. | |
| 401 | 25,000 | .0219 | −.0001 | .00073 | 0. | |
| 481 | 30,000 | .0270 | 0. | .00090 | 0. | |
| 561 | 35,000 | .0320 | −.0004 | .00107 | −.00001 | |
| 641 | 40,000 | .0372 | −.0006 | .00124 | −.00002 | |
| 721 | 45,000 | .0428 | −.0007 | .00143 | −.00002 | |
| 802 | 50,000 | .0480 | −.0007 | .00160 | −.00002 | |
| 882 | 55,000 | .0539 | −.0004 | .00180 | −.00001 | |
| 962 | 60,000 | .0598 | −.0001 | .00199 | 0. | |
| 1,042 | 65,000 | .0659 | 0. | .00220 | 0. | |
| 1,122 | 70,000 | .0722 | .0008 | .00241 | .00001 | |
| 1,202 | 75,000 | .0783 | .0012 | .00261 | .00004 | |
| 1,282 | 80,000 | .0850 | .0017 | .00283 | .00006 | |
| 1,363 | 85,000 | .0915 | .0027 | .00305 | .00009 | |
| 1,443 | 90,000 | .0992 | .0041 | .00331 | .00014 | |
| 1,523 | 95,000 | .1066 | .0053 | .00355 | .00018 | |
| 1,603 | 100,000 | .1149 | .0073 | .00383 | .00024 | |
| 1,683 | 105,000 | .1230 | .0100 | .00410 | .00033 | |
| 1,763 | 110,000 | .1317 | .0128 | .00439 | .00043 | |
| 1,843 | 115,000 | .1414 | .0160 | .00471 | .00053 | |
| 1,924 | 120,000 | .1518 | .0210 | .00506 | .00070 | |
| 2,003 | 125,000 | .1640 | .0261 | .00547 | .00087 | |
| 2,084 | 130,000 | .1758 | .0312 | .00586 | .00104 | |
| 2,164 | 135,000 | .1888 | .0388 | .00629 | .00129 | |
| 2,244 | 140,000 | .2040 | .0467 | .00680 | .00156 | |
| 2,324 | 145,000 | .2252 | .0593 | .00751 | .00198 | |
| 2,405 | 150,000 | .2415 | .0702 | .00805 | .00234 | |
| 2,485 | 155,000 | .2660 | .0855 | .00887 | .00285 | |
| 2,565 | 160,000 | .2950 | .1062 | .00983 | .00354 | |
| 2,645 | 165,000 | .3280 | .1307 | .01087 | .00436 | |
| 2,725 | 170,000 | .3680 | .1656 | .01227 | .00552 | |
| 3,077 | 191,800 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.82 in. in 30 in. = 2.2 per cent.
Dimensions at fracture, 0.095 by 0.095 in. Sectional area = 0.00902 sq. in.
Contraction of area, 43.8 per cent.
Position of fracture, 16.25 in. inside gauge marks.
Appearance of fracture, fine silky, cup shaped.

From same coil as 4–A or sample No. 4.

This sample was annealed at 1,500° F. for one hour and allowed to cool slowly in furnace for about nine hours; annealed the second time at 1,500° F. for three hours and allowed to cool in furnace for about nine hours.

Marks, 4–B.

Dimensions, 0.1271 by 0.1279 in.

Sectional area, 0.01625 sq. in.

Sectional area used as 0.01603 sq. in., this having been the average sectional area of the unannealed wire from the same coil.

Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb..* | *In.* | *In.* | *In.* | *In.* | |
| 80 | 5,000 | 0. | 0. | 0. | 0. | |
| 160 | 10,000 | .0071 | .0007 | .00024 | .00002 | |
| 240 | 15,000 | .0130 | .0012 | .00043 | .00004 | |
| 321 | 20,000 | .0188 | .0020 | .00063 | .00007 | |
| 401 | 25,000 | .0241 | .0027 | .00080 | .00009 | |
| 481 | 30,000 | .0298 | .0031 | .00099 | .00010 | |
| 561 | 35,000 | .0360 | .0040 | .00120 | .00013 | |
| 577 | 36,000 | .0375 | .0049 | .00125 | .00016 | |
| 593 | 37,000 | .0392 | .0053 | .00131 | .00018 | |
| 609 | 38,000 | .0408 | .0060 | .00136 | .00020 | |
| 625 | 39,000 | .0424 | .0064 | .00141 | .00021 | |
| 641 | 40,000 | .0440 | .0074 | .00147 | .00025 | |
| 657 | 41,000 | .0465 | .0083 | .00155 | .00028 | |
| 673 | 42,000 | .0490 | .0130 | .00163 | .00043 | |
| 689 | 43,000 | .0530 | .0130 | .00177 | .00043 | |
| 705 | 44,000 | .0850 | .0440 | .00283 | .00147 | |
| 721 | 45,000 | .1330 | .0908 | .00443 | .00303 | |
| 737 | 46,000 | .1640 | .1225 | .00547 | .00408 | |
| 753 | 47,000 | .2110 | .1652 | .00703 | .00551 | |
| 769 | 48,000 | .2470 | .1944 | .00823 | .00648 | |
| 785 | 49,000 | .2622 | .2078 | .00874 | .00693 | |
| 802 | 50,000 | .2880 | .2318 | .00960 | .00773 | |
| 818 | 51,000 | .3070 | .2488 | .01023 | .00829 | |
| 834 | 52,000 | .3280 | .2678 | .01093 | .00893 | |
| 850 | 53,000 | .3450 | .2870 | .01150 | .00957 | |
| 866 | 54,000 | .3772 | .3125 | .01257 | .01042 | |
| 1,443 | 88,800 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 2.96 in. in 30 in. = 9.9 per cent.

Dimensions at fracture, 0.111 by 0.111 in.

Sectional area, 0.01232 sq. in.

Contraction of area, 24.2 per cent.

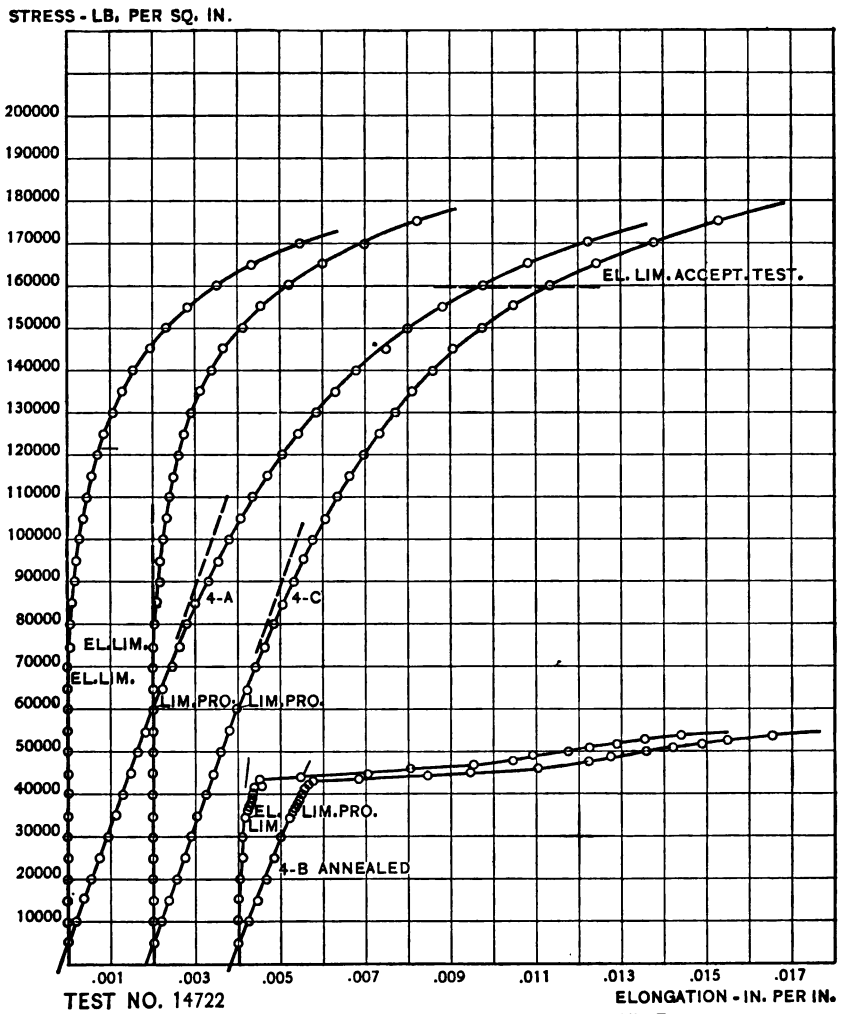
Position of fracture, 0.20 in. outside gauge marks.

Appearance of fracture, silky, trace of granulation.

Marks, 4–C. From same coil as 4–A.
Dimensions, 0.1263 by 0.1267 in.
Sectional area, 0.01600 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb..* | *In.* | *In.* | *In.* | *In.* | |
| 80 | 5,000 | 0. | 0. | 0. | 0. | |
| 160 | 10,000 | .0052 | — .0001 | 0.00017 | 0. | |
| 240 | 15,000 | .0110 | — .0005 | .00037 | — .00002 | |
| 321 | 20,000 | .0162 | — .0004 | .00054 | — .00001 | |
| 401 | 25,000 | .0217 | — .0006 | .00072 | — .00002 | |
| 481 | 30,000 | .0270 | — .0005 | .00090 | — .00002 | |
| 561 | 35,000 | .0319 | — .0006 | .00106 | — .00002 | |
| 641 | 40,000 | .0372 | — .0009 | .00124 | — .00003 | |
| 721 | 45,000 | .0430 | — .0010 | .00143 | — .00003 | |
| 802 | 50,000 | .0482 | — .0009 | .00161 | — .00003 | |
| 882 | 55,000 | .0542 | — .0010 | .00181 | — .00003 | |
| 962 | 60,000 | .0601 | — .0007 | .00200 | — .00002 | |
| 1,042 | 65,000 | .0660 | — .0004 | .00220 | — .00001 | |
| 1,122 | 70,000 | .0720 | 0. | .00240 | 0. | |
| 1,202 | 75,000 | .0784 | .0009 | .00261 | .00003 | |
| 1,282 | 80,000 | .0850 | .0013 | .00283 | .00004 | |
| 1,363 | 85,000 | .0918 | .0023 | .00306 | .00008 | |
| 1,443 | 90,000 | .0990 | .0032 | .00330 | .00011 | |
| 1,523 | 95,000 | .1060 | .0043 | .00353 | .00014 | |
| 1,603 | 100,000 | .1130 | .0062 | .00377 | .00021 | |
| 1,683 | 105,000 | .1225 | .0091 | .00408 | .00030 | |
| 1,763 | 110,000 | .1305 | .0113 | .00435 | .00038 | |
| 1,843 | 115,000 | .1390 | .0141 | .00463 | .00047 | |
| 1,924 | 120,000 | .1490 | .0180 | .00497 | .00060 | |
| 2,003 | 125,000 | .1594 | .0220 | .00531 | .00073 | |
| 2,084 | 130,000 | .1719 | .0279 | .00573 | .00093 | |
| 2,164 | 135,000 | .1847 | .0341 | .00616 | .00114 | |
| 2,244 | 140,000 | .1991 | .0420 | .00664 | .00140 | |
| 2,324 | 145,000 | .2130 | .0502 | .00710 | .00167 | |
| 2,405 | 150,000 | .2345 | .0635 | .00782 | .00212 | |
| 2,485 | 155,000 | .2550 | .0770 | .00850 | .00257 | |
| 2,565 | 160,000 | .2820 | .0962 | .00940 | .00321 | |
| 2,645 | 165,000 | .3140 | .1207 | .01047 | .00402 | |
| 2,725 | 170,000 | .3550 | .1518 | .01183 | .00506 | |
| 2,805 | 175,000 | .3990 | .1870 | .01330 | .00623 | |
| 3,106 | 194,000 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.71 in. in 30 in. = 2.4 per cent.
Dimensions at fracture, 0.097 by 0.097 in.
Sectional area, 0.00941 sq. in.
Contraction of area, 41.2 per cent.
Position of fracture, 0.30 in. inside gauge marks.
Appearance of fracture, fine silky, cup shaped.




TENSILE TESTS OF SQUARE STEEL WIRE
FOR WINDING GUNS.
DETERMINATION OF ELASTIC LIMIT.

Sample No. 5. Reel 946. P. O. 8320. Diameter of coil in natural state, 25 inches.
Marks, 5–A.
Dimensions, 0.1268 by 0.1282 in.
Sectional area, 0.01625 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 81 | 5,000 | 0. | 0. | 0. | 0. | |
| 163 | 10,000 | .0056 | 0. | .00019 | 0. | |
| 244 | 15,000 | .0110 | —.0001 | .00037 | —.00001 | |
| 325 | 20,000 | .0165 | 0. | .00055 | 0. | |
| 406 | 25,000 | .0220 | —.0002 | .00073 | —.00001 | |
| 488 | 30,000 | .0271 | —.0002 | .00090 | —.00001 | |
| 569 | 35,000 | .0330 | 0. | .00110 | 0. | |
| 650 | 40,000 | .0390 | 0. | .00130 | 0. | |
| 731 | 45,000 | .0450 | .0003 | .00150 | .00001 | |
| 813 | 50,000 | .0510 | .0003 | .00170 | .00001 | |
| 894 | 55,000 | .0570 | .0005 | .00190 | .00002 | |
| 975 | 60,000 | .0630 | .0012 | .00210 | .00004 | |
| 1,056 | 65,000 | .0695 | .0018 | .00232 | .00006 | |
| 1,138 | 70,000 | .0760 | .0021 | .00252 | .00007 | |
| 1,219 | 75,000 | .0822 | .0032 | .00274 | .00011 | |
| 1,300 | 80,000 | .0890 | .0040 | .00297 | .00013 | |
| 1,381 | 85,000 | .0960 | .0049 | .00320 | .00016 | |
| 1,463 | 90,000 | .1050 | .0069 | .00350 | .00023 | |
| 1,544 | 95,000 | .1120 | .0080 | .00373 | .00027 | |
| 1,625 | 100,000 | .1205 | .0110 | .00402 | .00037 | |
| 1,706 | 105,000 | .1300 | .0140 | .00433 | .00047 | |
| 1,788 | 110,000 | .1395 | .0170 | .00465 | .00057 | |
| 1,869 | 115,000 | .1500 | .0208 | .00500 | .00069 | |
| 1,950 | 120,000 | .1615 | .0263 | .00538 | .00088 | |
| 2,031 | 125,000 | .1759 | .0335 | .00586 | .00112 | |
| 2,113 | 130,000 | .1890 | .0400 | .00630 | .00133 | |
| 2,194 | 135,000 | .2060 | .0500 | .00687 | .00167 | |
| 2,275 | 140,000 | .2247 | .0610 | .00749 | .00203 | |
| 2,356 | 145,000 | .2460 | .0753 | .00820 | .00251 | |
| 2,438 | 150,000 | .2720 | .0925 | .00907 | .00308 | |
| 2,519 | 155,000 | .3000 | .1141 | .01000 | .00380 | |
| 2,600 | 160,000 | .3375 | .1410 | .01125 | .00470 | |
| 2,681 | 165,000 | .3795 | .1792 | .01265 | .00597 | |
| 2,977 | 183,000 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.68 in. in 30 in. = 2.3 per cent.
Dimensions at fracture, 0.097 by 0.097 in.
Sectional area, 0.00941 sq. in.
Contraction of area, 42 per cent.
Position of fracture, 9.60 in. inside gauge marks.
Appearance of fracture, fine silky.

From same coil as 5–A or sample No. 5. This sample was annealed at 1,500° F. for one hour and allowed to cool slowly in furnace for about nine hours; annealed the second time at 1,500° F. for three hours and allowed to cool in furnace for about nine hours.

Marks, 5–B.

Dimensions, 0.1270 by 0.1278 in.

Sectional area, 0.01623 sq. in.

Sectional area used, 0.01625 sq. in., this having been the sectional area of the unannealed wire from the same coil.

Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 81 | 5,000 | 0. | 0. | 0. | 0. | |
| 163 | 10,000 | .0071 | .0009 | .00024 | .00003 | |
| 244 | 15,000 | .0125 | .0009 | .00042 | .00003 | |
| 325 | 20,000 | .0180 | .0010 | .00060 | .00003 | |
| 406 | 25,000 | .0232 | .0012 | .00077 | .00004 | |
| 488 | 30,000 | .0283 | .0017 | .00094 | .00006 | |
| 569 | 35,000 | .0346 | .0021 | .00115 | .00007 | |
| 585 | 36,000 | .0360 | .0028 | .00120 | .00009 | |
| 601 | 37,000 | .0374 | .0029 | .00125 | .00010 | |
| 618 | 38,000 | .0390 | .0030 | .00130 | .00010 | |
| 634 | 39,000 | .0400 | .0032 | .00133 | .00011 | |
| 650 | 40,000 | .0418 | .0040 | .00139 | .00013 | |
| 666 | 41,000 | .0439 | .0050 | .00146 | .00017 | |
| 683 | 42,000 | .0510 | .0110 | .00170 | .00037 | |
| 699 | 43,000 | .0735 | .0322 | .00245 | .00107 | |
| 715 | 44,000 | .1140 | .0710 | .00380 | .00237 | |
| 731 | 45,000 | .1460 | .1030 | .00487 | .00343 | |
| 748 | 46,000 | .1760 | .1282 | .00587 | .00427 | |
| 764 | 47,000 | .2000 | .1534 | .00667 | .00511 | |
| 780 | 48,000 | .2500 | .1990 | .00833 | .00663 | |
| 796 | 49,000 | .2900 | .2370 | .00967 | .00790 | |
| 813 | 50,000 | .3100 | .2540 | .01033 | .00847 | |
| 829 | 51,000 | .3260 | .2710 | .01087 | .00903 | |
| 845 | 52,000 | .3500 | .2912 | .01167 | .00971 | |
| 861 | 53,000 | .3800 | .3230 | .01267 | .01077 | |
| 1,411 | 87,000 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 2.79 in. in 30 in. = 9.3 per cent.

Dimensions at fracture, 0.105 by 0.105 in.

Sectional area, 0.01103 sq. in.

Contraction of area, 32 per cent.

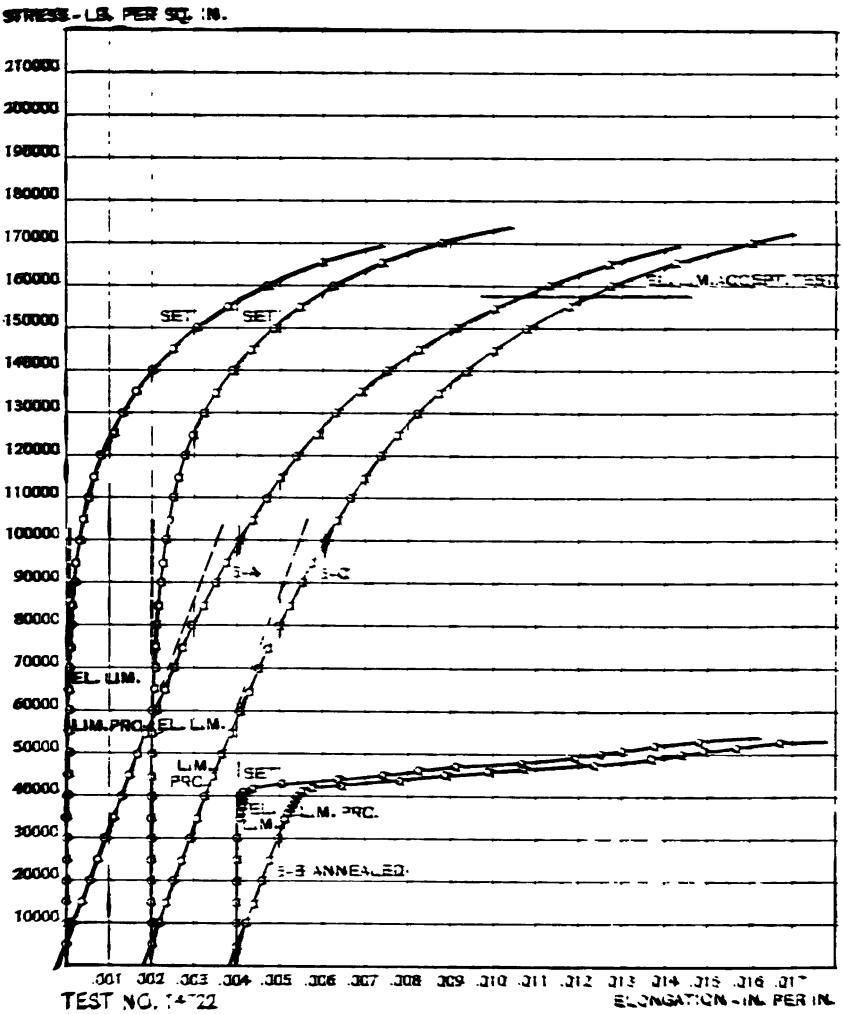
Position of fracture, at gauge mark.

Appearance of fracture, silky.

From same coil as 5–A or sample No. 5.
Marks, 5–C.
Dimensions, 0.1270 by 0.1280 in.
Sectional area, 0.01625 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 81 | 5,000 | 0. | 0. | 0. | 0. | |
| 163 | 10,000 | .0051 | − .0001 | .00017 | 0. | |
| 244 | 15,000 | .0110 | − .0002 | .00037 | − .00001 | |
| 325 | 20,000 | .0162 | − .0001 | .00054 | 0. | |
| 406 | 25,000 | .0220 | − .0001 | .00073 | 0. | |
| 488 | 30,000 | .0275 | 0. | .00092 | 0. | |
| 569 | 35,000 | .0332 | 0. | .00111 | 0. | |
| 650 | 40,000 | .0385 | 0. | .00128 | 0. | |
| 731 | 45,000 | .0442 | .0004 | .00147 | .00001 | |
| 813 | 50,000 | .0505 | .0004 | .00168 | .00001 | |
| 894 | 55,000 | .0567 | .0008 | .00189 | .00003 | |
| 975 | 60,000 | .0630 | .0013 | .00210 | .00004 | |
| 1,056 | 65,000 | .0695 | .0020 | .00232 | .00007 | |
| 1,138 | 70,000 | .0759 | .0028 | .00253 | .00009 | |
| 1,219 | 75,000 | .0830 | .0035 | .00277 | .00012 | |
| 1,300 | 80,000 | .0895 | .0040 | .00298 | .00013 | |
| 1,381 | 85,000 | .0970 | .0060 | .00323 | .00020 | |
| 1,463 | 90,000 | .1040 | .0071 | .00347 | .00024 | |
| 1,544 | 95,000 | .1129 | .0090 | .00376 | .00030 | |
| 1,625 | 100,000 | .1210 | .0112 | .00403 | .00037 | |
| 1,706 | 105,000 | .1295 | .0133 | .00432 | .00044 | |
| 1,788 | 110,000 | .1390 | .0163 | .00463 | .00054 | |
| 1,869 | 115,000 | .1490 | .0200 | .00497 | .00067 | |
| 1,950 | 120,000 | .1595 | .0240 | .00532 | .00080 | |
| 2,031 | 125,000 | .1720 | .0293 | .00573 | .00098 | |
| 2,113 | 130,000 | .1850 | .0361 | .00617 | .00120 | |
| 2,194 | 135,000 | .2010 | .0450 | .00670 | .00150 | |
| 2,275 | 140,000 | .2205 | .0566 | .00735 | .00189 | |
| 2,356 | 145,000 | .2400 | .0690 | .00800 | .00230 | |
| 2,438 | 150,000 | .2630 | .0850 | .00877 | .00283 | |
| 2,519 | 155,000 | .2912 | .1040 | .00971 | .00347 | |
| 2,600 | 160,000 | .3220 | .1270 | .01073 | .00423 | |
| 2,681 | 165,000 | .3657 | .1607 | .01219 | .00536 | |
| 2,762 | 170,000 | .4200 | .2033 | .01400 | .00678 | |
| 3,035 | 186,600 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.75 in. in 30 in. = 2.5 per cent.
Dimensions at fracture, 0.098 by 0.098 in. Sectional area, 0.0096 sq. in.
Contraction of area, 40.9 per cent.
Position of fracture, at gauge mark.
Appearance of fracture, fine silky.




TENSILE TESTS OF SQUARE STEEL WIRE
FOR WINDING GUNS.
DETERMINATION OF ELASTIC LIMIT.

Sample No. 6. Reel 22. P. O. 8998. Diameter of coil in natural state, 21.5 in.

Marks, 6–A.

Dimensions, 0.1015 by 0.1021 in.

Sectional area, 0.01036 sq. in.

Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 52 | 5,020 | 0. | 0. | 0. | 0. | |
| 104 | 10,040 | .0062 | 0. | .00021 | 0. | |
| 156 | 15,060 | .0112 | 0. | .00037 | 0. | |
| 208 | 20,080 | .0165 | − .0004 | .00055 | − .00001 | |
| 260 | 25,100 | .0215 | − .0006 | .00072 | − .00002 | |
| 312 | 30,140 | .0268 | − .0003 | .00089 | − .00001 | |
| 364 | 35,140 | .0330 | − .0008 | .00110 | − .00003 | |
| 416 | 40,160 | .0375 | − .0008 | .00125 | − .00003 | |
| 468 | 45,180 | .0430 | − .0011 | .00143 | − .00004 | |
| 520 | 50,200 | .0490 | − .0004 | .00163 | − .00001 | |
| 571 | 55,120 | .0538 | − .0005 | .00179 | − .00002 | |
| 623 | 60,140 | .0587 | − .0005 | .00199 | − .00002 | |
| 675 | 65,160 | .0658 | .0002 | .00219 | .00001 | |
| 727 | 70,180 | .0702 | .0002 | .00234 | .00001 | |
| 779 | 75,200 | .0755 | 0. | .00252 | 0. | |
| 831 | 80,220 | .0816 | .0003 | .00272 | .00001 | |
| 883 | 85,240 | .0877 | .0018 | .00292 | .00006 | |
| 935 | 90,260 | .0938 | .0020 | .00313 | .00007 | |
| 987 | 95,280 | .0995 | .0029 | .00332 | .00010 | |
| 1,039 | 100,300 | .1055 | .0035 | .00352 | .00012 | |
| 1,091 | 105,300 | .1120 | .0042 | .00373 | .00014 | |
| 1,143 | 110,300 | .1180 | .0053 | .00393 | .00018 | |
| 1,195 | 115,300 | .1238 | .0057 | .00413 | .00019 | |
| 1,247 | 120,400 | .1308 | .0073 | .00436 | .00024 | |
| 1,299 | 125,400 | .1380 | .0087 | .00460 | .00029 | |
| 1,351 | 130,400 | .1445 | .0095 | .00482 | .00032 | |
| 1,403 | 135,400 | .1510 | .0105 | .00503 | .00035 | |
| 1,455 | 140,400 | .1584 | .0120 | .00528 | .00040 | |
| 1,507 | 145,500 | .1642 | .0123 | .00547 | .00041 | |
| 1,559 | 150,500 | .1720 | .0135 | .00573 | .00045 | |
| 1,610 | 155,400 | .1792 | .0150 | .00597 | .00050 | |
| 1,622 | 156,600 | .1859 | .0162 | .00620 | .00054 | |
| 1,714 | 165,500 | .1941 | .0180 | .00647 | .00060 | |
| 1,766 | 170,500 | .2029 | .0202 | .00676 | .00067 | |
| 1,818 | 175,500 | .2100 | .0230 | .00700 | .00077 | |
| 1,870 | 180,500 | .2190 | .0250 | .00730 | .00083 | |
| 1,922 | 185,500 | .2270 | .0285 | .00757 | .00095 | |
| 1,974 | 190,600 | .2400 | .0330 | .00800 | .00110 | |
| 2,026 | 195,600 | .2493 | .0369 | .00831 | .00123 | |
| 2,078 | 200,600 | .2605 | .0400 | .00868 | .00133 | |
| 2,130 | 205,600 | .2722 | .0440 | .00907 | .00147 | |
| 2,182 | 210,600 | .2848 | .0515 | .00949 | .00172 | |
| 2,234 | 215,700 | .3010 | .0600 | .01003 | .00200 | |
| 2,286 | 220,700 | .3188 | .0700 | .01063 | .00233 | |
| 2,338 | 225,700 | .3405 | .0840 | .01135 | .00280 | |
| 2,390 | 230,700 | .3690 | .1033 | .01230 | .00344 | |
| 2,523 | 243,500 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture: 0.05 in. in 30 in. = 0.17 per cent.

When the fracture occurred the recoil put several small kinks in the wire.

Dimensions at fracture: 0.099 by 0.099 in.

Sectional area: 0.0098 sq. in.

Contraction of area: 5.4 per cent.

Position of fracture: 3.50 in. inside gauge marks.

Appearance of fracture: Fine silky, serrated.

This sample was annealed at 1,500° F. for one hour and allowed to cool slowly in furnace for about nine hours; annealed the second time at 1,500° F. for three hours and allowed to cool in furnace for about nine hours.

Marks, 6–B,—from same coil as 6–A.
Dimensions, 0.1016 by 0.1020 in.
Sectional area, 0.01036 sq. in.
Gauged length, 30 in.

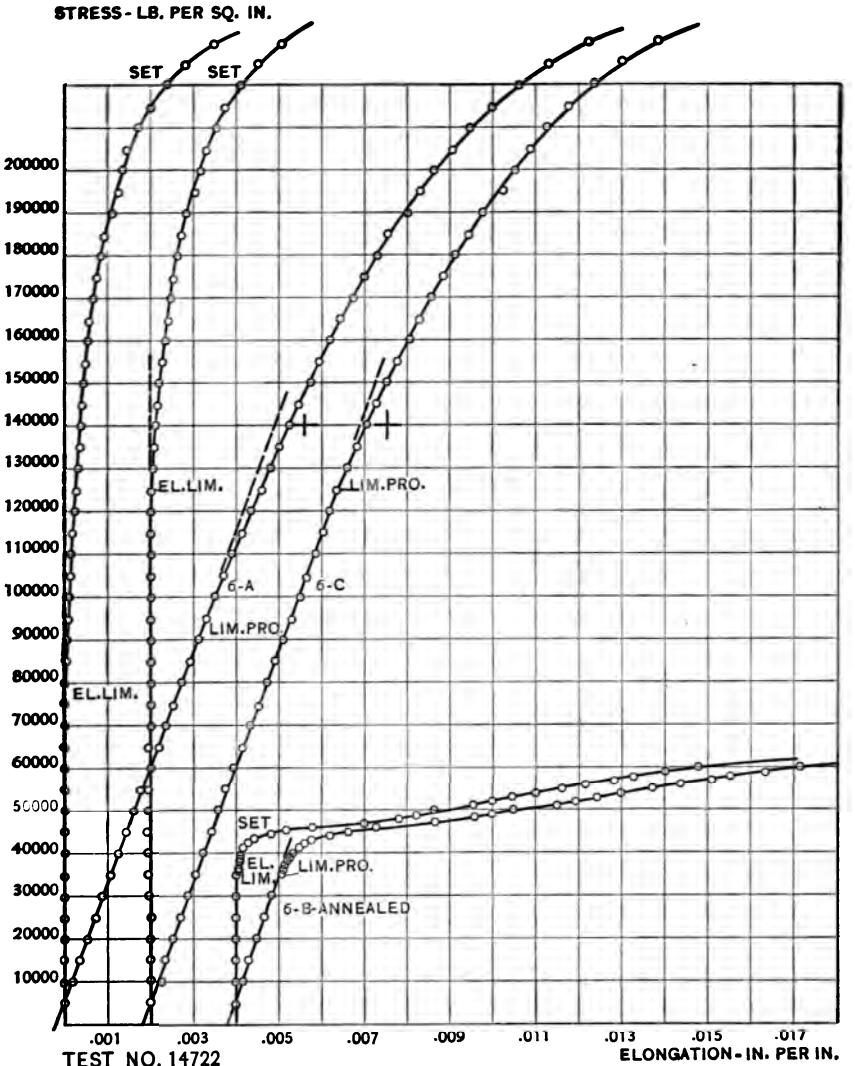
| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 52 | 5,020 | 0. | 0. | 0. | 0. | |
| 104 | 10,040 | .0041 | −.0001 | .00014 | −.000003 | |
| 156 | 15,060 | .0091 | −.0010 | .00030 | −.00003 | |
| 208 | 20,080 | .0140 | −.0010 | .00047 | −.00003 | |
| 260 | 25,100 | .0200 | −.0006 | .00067 | −.00002 | |
| 312 | 30,140 | .0256 | −.0001 | .00085 | −.000003 | |
| 364 | 35,140 | .0322 | .0005 | .00107 | .00002 | |
| 374 | 36,100 | .0340 | .0011 | .00113 | .00004 | |
| 384 | 37,070 | .0351 | .0011 | .00117 | .00004 | |
| 395 | 38,130 | .0369 | .0020 | .00123 | .00007 | |
| 405 | 39,100 | .0387 | .0025 | .00129 | .00008 | |
| 416 | 40,160 | .0407 | .0030 | .00136 | .00010 | |
| 426 | 41,120 | .0433 | .0048 | .00144 | .00016 | |
| 436 | 42,090 | .0469 | .0070 | .00156 | .00023 | |
| 447 | 43,150 | .0510 | .0100 | .00170 | .00033 | |
| 457 | 44,120 | .0660 | .0250 | .00220 | .00083 | |
| 468 | 45,180 | .0790 | .0350 | .00263 | .00117 | |
| 478 | 46,140 | .0990 | .0530 | .00330 | .00177 | |
| 488 | 47,110 | .1400 | .0910 | .00467 | .00303 | |
| 499 | 48,170 | .1680 | .1149 | .00560 | .00383 | |
| 509 | 49,130 | .1790 | .1270 | .00597 | .00423 | |
| 520 | 50,200 | .1940 | .1395 | .00647 | .00465 | |
| 530 | 51,130 | .2250 | .1670 | .00750 | .00557 | |
| 540 | 52,120 | .2390 | .1797 | .00797 | .00599 | |
| 551 | 53,190 | .2530 | .1922 | .00843 | .00641 | |
| 561 | 54,160 | .2710 | .2113 | .00903 | .00704 | |
| 571 | 55,120 | .2920 | .2288 | .00973 | .00763 | |
| 582 | 56,180 | .3110 | .2458 | .01037 | .00819 | |
| 592 | 57,140 | .3328 | .2645 | .01109 | .00882 | |
| 603 | 58,200 | .3460 | .2788 | .01153 | .00929 | |
| 613 | 59,170 | .3710 | .3015 | .01237 | .01005 | |
| 623 | 60,140 | .3950 | .3230 | .01317 | .01077 | |
| 951 | 91,800 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 1.85 in. in 30 in. = 6.2 per cent.
Dimensions at fracture, 0.088 by 0.090 in.
Sectional area, 0.00792 sq. in.
Contraction of area, 23.6 per cent.
Position of fracture, 0.30 in. inside gauge marks.
Appearance of fracture, silky.

From same coil as 6–A or sample No. 6.
Marks, 6–C.
Dimensions, 0.1019 by 0.1023 in.
Sectional area, 0.01042 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 52 | 4,990 | 0. | 0. | 0. | 0. | |
| 104 | 9,980 | .0072 | .0002 | .00024 | .00001 | |
| 156 | 14,970 | .0110 | 0. | .00037 | 0. | |
| 208 | 19,960 | .0160 | −.0002 | .00053 | −.00001 | |
| 260 | 24,950 | .0215 | −.0005 | .00072 | −.00002 | |
| 312 | 29,950 | .0270 | −.0018 | .00090 | −.00006 | |
| 364 | 34,930 | .0322 | −.0018 | .00107 | −.00006 | |
| 416 | 39,930 | .0375 | −.0020 | .00125 | −.00007 | |
| 468 | 44,920 | .0430 | −.0019 | .00143 | −.00006 | |
| 520 | 49,910 | .0488 | −.0020 | .00163 | −.00007 | |
| 571 | 54,800 | .0540 | −.0017 | .00180 | −.00006 | |
| 623 | 59,800 | .0591 | −.0010 | .00197 | −.00003 | |
| 675 | 64,780 | .0650 | −.0015 | .00217 | −.00005 | |
| 727 | 69,780 | .0705 | −.0010 | .00235 | −.00003 | |
| 779 | 74,760 | .0763 | −.0006 | .00254 | −.00002 | |
| 831 | 79,760 | .0821 | −.0004 | .00274 | −.00001 | |
| 883 | 84,740 | .0879 | 0. | .00293 | 0. | |
| 935 | 89,740 | .0933 | −.0003 | .00311 | −.00001 | |
| 987 | 94,730 | .0989 | .0001 | .00330 | .00003 | |
| 1,039 | 99,710 | .1044 | 0. | .00348 | 0. | |
| 1,091 | 104,700 | .1100 | .0001 | .00367 | .00003 | |
| 1,143 | 109,700 | .1150 | .0002 | .00383 | .00001 | |
| 1,195 | 114,700 | .1210 | .0001 | .00403 | .00003 | |
| 1,247 | 119,700 | .1260 | 0. | .00420 | 0. | |
| 1,299 | 124,700 | .1315 | −.0003 | .00438 | −.00001 | |
| 1,351 | 129,700 | .1385 | .0003 | .00462 | .00001 | |
| 1,403 | 134,600 | .1455 | .0019 | .00485 | .00006 | |
| 1,455 | 139,600 | .1520 | .0030 | .00507 | .00010 | |
| 1,507 | 144,600 | .1590 | .0043 | .00530 | .00014 | |
| 1,559 | 149,600 | .1663 | .0060 | .00554 | .00020 | |
| 1,610 | 154,500 | .1740 | .0079 | .00580 | .00026 | |
| 1,622 | 155,700 | .1818 | .0105 | .00606 | .00035 | |
| 1,714 | 164,500 | .1890 | .0120 | .00630 | .00040 | |
| 1,766 | 169,500 | .1978 | .0140 | .00659 | .00047 | |
| 1,818 | 174,500 | .2060 | .0161 | .00687 | .00054 | |
| 1,870 | 179,500 | .2145 | .0193 | .00715 | .00064 | |
| 1,922 | 184,500 | .2240 | .0220 | .00747 | .00073 | |
| 1,974 | 189,500 | .2337 | .0259 | .00779 | .00086 | |
| 2,026 | 194,400 | .2480 | .0325 | .00827 | .00108 | |
| 2,078 | 199,400 | .2562 | .0358 | .00854 | .00119 | |
| 2,130 | 204,400 | .2680 | .0400 | .00893 | .00133 | |
| 2,182 | 209,400 | .2800 | .0455 | .00933 | .00152 | |
| 2,234 | 214,400 | .2950 | .0530 | .00983 | .00177 | |
| 2,286 | 219,400 | .3130 | .0638 | .01043 | .00213 | |
| 2,338 | 224,400 | .3320 | .0755 | .01107 | .00252 | |
| 2,390 | 229,400 | .3580 | .0920 | .01193 | .00307 | |
| 2,452 | 235,300 | ..... | ..... | ..... | ..... | Tensile strength. |

Gauged length after fracture, 29.98 in. = 0 per cent.
When the fracture occurred the recoil put several small kinks in the wire.
Dimensions at fracture, 0.099 by 0.099 in.
Sectional area, 0.098 sq. in.
Contraction of area, 5.95 per cent.
Position of fracture, 3.95 in. inside gauge marks.
Appearance of fracture, fine silky, serrated.




TENSILE TESTS OF SQUARE STEEL WIRE
FOR WINDING GUNS.
DETERMINATION OF ELASTIC LIMIT

Diameter of coil in natural state = 31.00 in.
Marks, 7–A.
Dimensions, 0.1038 by 0.1020 in.
Sectional area, 0.01058 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lbs.* | *Lbs.* | *In.* | *In.* | *In.* | *In.* | |
| 53 | 5,000 | 0. | 0. | 0. | 0. | |
| 106 | 10,000 | .0053 | .0015 | .00018 | .00005 | |
| 212 | 20,000 | .0160 | .0013 | .00053 | .00004 | |
| 318 | 30,000 | .0260 | .0002 | .00087 | .00001 | |
| 424 | 40,000 | .0370 | 0. | .00123 | 0. | |
| 530 | 50,000 | .0480 | 0. | .00160 | 0. | |
| 635 | 60,000 | .0588 | 0. | .00196 | 0. | |
| 741 | 70,000 | .0708 | .0002 | .00236 | .00001 | |
| 847 | 80,000 | .0820 | .0002 | .00273 | .00001 | |
| 953 | 90,000 | .0940 | .0011 | .00313 | .00004 | |
| 1,059 | 100,000 | .1065 | .0023 | .00355 | .00008 | |
| 1,112 | 105,000 | .1125 | .0031 | .00375 | .00010 | |
| 1,165 | 110,000 | .1190 | .0039 | .00397 | .00013 | |
| 1,218 | 115,000 | .1253 | .0045 | .00418 | .00015 | |
| 1,271 | 120,000 | .1320 | .0063 | .00440 | .00021 | |
| 1,324 | 125,000 | .1385 | .0065 | .00462 | .00022 | |
| 1,377 | 130,000 | .1460 | .0075 | .00487 | .00025 | |
| 1,430 | 135,000 | .1528 | .0085 | .00509 | .00028 | |
| 1,483 | 140,000 | .1600 | .0098 | .00533 | .00033 | |
| 1,536 | 145,000 | .1673 | .0110 | .00558 | .00037 | |
| 1,589 | 150,000 | .1750 | .0129 | .00583 | .00043 | |
| 1,641 | 155,000 | .1828 | .0140 | .00609 | .00047 | |
| 1,694 | 160,000 | .1905 | .0165 | .00635 | .00055 | |
| 1,747 | 165,000 | .1990 | .0185 | .00663 | .00062 | |
| 1,800 | 170,000 | .2077 | .0208 | .00692 | .00069 | |
| 1,906 | 180,000 | .2268 | .0277 | .00756 | .00092 | |
| 2,012 | 190,000 | .2480 | .0340 | .00827 | .00113 | |
| 2,118 | 200,000 | .2700 | .0442 | .00900 | .00147 | |
| 2,224 | 210,000 | .3065 | .0650 | .01022 | .00217 | |
| 2,445 | 231,000 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.21 in. in 30 in. = 0.7 per cent.
Dimensions at fracture, 0.079 by 0.079 in.
Sectional area: 0.00625 sq. in.
Contraction of area, 41 per cent.
Position of fracture, 9.40 in. inside gauge marks.
Appearance of fracture, fine silky, cup shaped.

This sample was annealed at 1,500° F. for one hour and allowed to cool slowly in the furnace for about nine hours; annealed the second time at 1,500° F. for three hours and allowed to cool in furnace for about nine hours.

Marks, 7–B,—from same coil as 7–A.
Dimensions, 0.1031 by 0.1021 in.
Sectional area, 0.010526 sq. in.
Gauged length, 30 in.

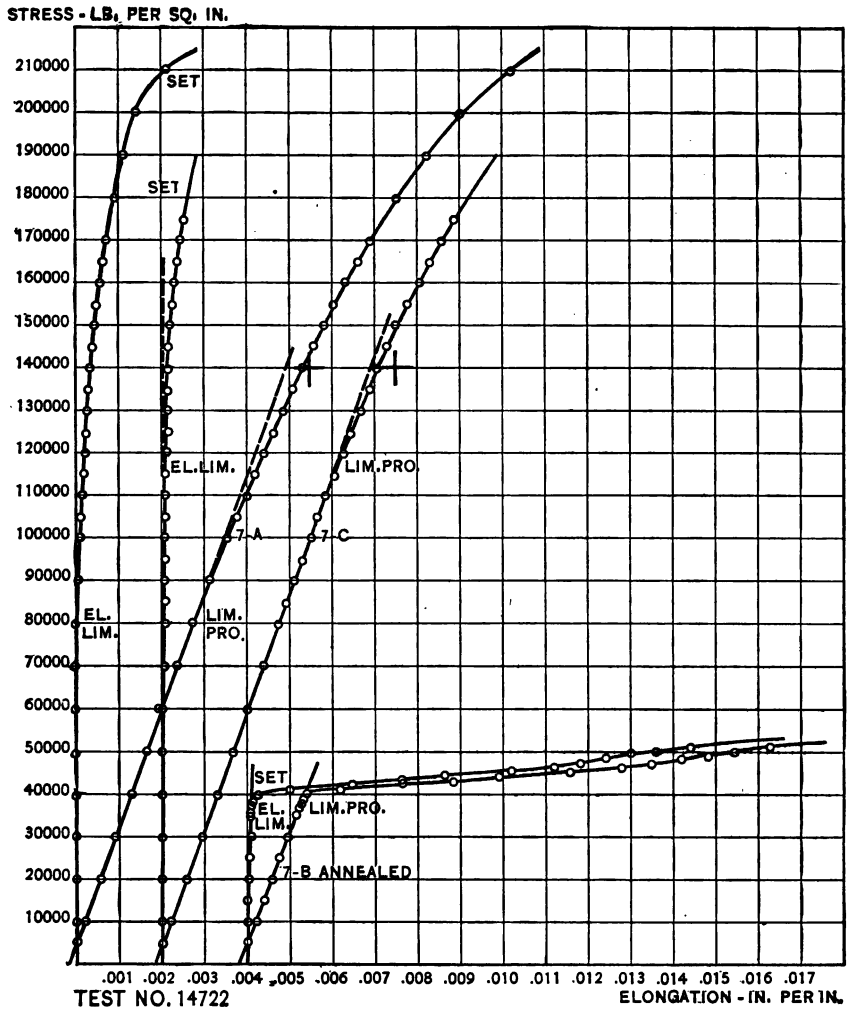
| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Pounds.* | *Pounds.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | |
| 53 | 5,036 | 0. | 0. | 0. | 0. | |
| 106 | 10,070 | .0059 | 0. | .00020 | 0. | |
| 159 | 15,110 | .0110 | −.0002 | .00037 | −.00001 | |
| 212 | 20,140 | .0165 | 0. | .00055 | 0. | |
| 265 | 25,180 | .0220 | 0. | .00073 | 0. | |
| 318 | 30,210 | .0280 | .0010 | .00093 | .00003 | |
| 371 | 35,250 | .0342 | .0022 | .00114 | .00007 | |
| 381 | 36,200 | .0360 | .0030 | .00120 | .00010 | |
| 392 | 37,240 | .0380 | .0031 | .00127 | .00010 | |
| 402 | 38,200 | .0390 | .0042 | .00130 | .00014 | |
| 413 | 39,240 | .0412 | .0056 | .00137 | .00019 | |
| 424 | 40,280 | .0450 | .0083 | .00150 | .00028 | |
| 434 | 41,230 | .0660 | .0304 | .00220 | .00101 | |
| 445 | 42,280 | .1100 | .0729 | .00367 | .00243 | |
| 455 | 43,230 | .1450 | .1100 | .00483 | .00367 | |
| 466 | 44,270 | .1780 | .1382 | .00593 | .00461 | |
| 477 | 45,320 | .2280 | .1865 | .00760 | .00622 | |
| 487 | 46,270 | .2650 | .2162 | .00883 | .00721 | |
| 498 | 47,320 | .2860 | .2350 | .00953 | .00783 | |
| 508 | 48,270 | .3070 | .2540 | .01023 | .00847 | |
| 519 | 49,310 | .3260 | .2710 | .01087 | .00903 | |
| 530 | 50,360 | .3450 | .2892 | .01150 | .00964 | |
| 540 | 51,300 | .3700 | .3140 | .01230 | .01047 | |
| 889 | 84,460 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 2.62 in. in 30 in. = 8.7 per cent.
Diameter at fracture, 0.085 by 0.085 in.
Sectional area, 0.00723 sq. in.
Contraction of area, 31.3 per cent.
Position of fracture, 1.65 in. inside gauge marks.
Appearance of fracture, dull silky.

Marks, 7–C,—from same coil as 7–A.
Dimensions, 0.1038 by 0.1021 in.
Sectional area, 0.0105979 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 53 | 5,000 | 0. | 0. | 0. | 0. | |
| 106 | 10,000 | .0061 | .0010 | .00020 | .00003 | |
| 212 | 20,000 | .0170 | 0. | .00057 | 0. | |
| 318 | 30,000 | .0270 | .0004 | .00090 | .00001 | |
| 424 | 40,000 | .0382 | .0005 | .00127 | .00002 | |
| 530 | 50,000 | .0492 | 0. | .00164 | 0. | |
| 635 | 60,000 | .0595 | 0. | .00198 | 0. | |
| 741 | 70,000 | .0710 | .0002 | .00237 | .00001 | |
| 847 | 80,000 | .0820 | .0009 | .00273 | .00003 | |
| 900 | 85,000 | .0875 | .0010 | .00292 | .00003 | |
| 953 | 90,000 | .0935 | .0010 | .00312 | .00003 | |
| 1,006 | 95,000 | .0995 | .0011 | .00332 | .00004 | |
| 1,059 | 100,000 | .1050 | 0. | .00350 | 0. | |
| 1,112 | 105,000 | .1102 | .0015 | .00367 | .00005 | |
| 1,165 | 110,000 | .1161 | .0018 | .00387 | .00006 | |
| 1,218 | 115,000 | .1223 | .0016 | .00408 | .00005 | |
| 1,271 | 120,000 | .1290 | .0025 | .00430 | .00008 | |
| 1,324 | 125,000 | .1345 | .0028 | .00448 | .00009 | |
| 1,377 | 130,000 | .1415 | .0030 | .00472 | .00010 | |
| 1,430 | 135,000 | .1470 | .0028 | .00490 | .00009 | |
| 1,483 | 140,000 | .1528 | .0033 | .00509 | .00011 | |
| 1,536 | 145,000 | .1600 | .0048 | .00533 | .00016 | |
| 1,589 | 150,000 | .1665 | .0060 | .00555 | .00020 | |
| 1,642 | 155,000 | .1750 | .0077 | .00583 | .00026 | |
| 1,694 | 160,000 | .1835 | .0089 | .00612 | .00030 | |
| 1,747 | 165,000 | .1900 | .0110 | .00633 | .00037 | |
| 1,800 | 170,000 | .1990 | .0132 | .00663 | .00044 | |
| 1,853 | 175,000 | .2073 | .0152 | .00691 | .00051 | |
| 2,484 | 234,600 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.15 in. in 30 in. = .50 per cent.
When the fracture occurred the recoil put several small kinks in the wire.
Diameter at fracture, 0.079 by 0.079 sq. in.
Sectional area, 0.00625 sq. in.
Contraction of area, 40.9 per cent.
Position of fracture, 0.30 in. inside gauge marks.
Appearance of fracture, fine silky, cup shaped.




TENSILE TESTS OF SQUARE STEEL WIRE FOR WINDING GUNS.
DETERMINATION OF ELASTIC LIMIT.

Sample No. 8. Reel 33. P. O. 8025. Diam. of coil in natural state, 43.50 in.
Marks, 8–A.
Dimensions, 0.1013 by 0.1013 in.
Sectional area, 0.01026 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 51 | 5,000 | 0. | 0. | 0. | 0. | |
| 103 | 10,000 | .0059 | 0. | .00020 | 0. | |
| 205 | 20,000 | .0167 | 0. | .00056 | 0. | |
| 308 | 30,000 | .0285 | 0. | .00095 | 0. | |
| 411 | 40,000 | .0392 | .0005 | .00131 | .00002 | |
| 514 | 50,000 | .0508 | .0010 | .00169 | .00003 | |
| 616 | 60,000 | .0645 | .0018 | .00215 | .00006 | |
| 719 | 70,000 | .0750 | .0027 | .00250 | .00009 | |
| 822 | 80,000 | .0875 | .0040 | .00292 | .00013 | |
| 873 | 85,000 | .0950 | .0052 | .00317 | .00017 | |
| 924 | 90,000 | .1030 | .0060 | .00343 | .00020 | |
| 976 | 95,000 | .1112 | .0085 | .00371 | .00028 | |
| 1,027 | 100,000 | .1180 | .0100 | .00393 | .00033 | |
| 1,078 | 105,000 | .1273 | .0121 | .00424 | .00040 | |
| 1,130 | 110,000 | .1350 | .0150 | .00450 | .00050 | |
| 1,181 | 115,000 | .1445 | .0180 | .00482 | .00060 | |
| 1,232 | 120,000 | .1537 | .0210 | .00512 | .00070 | |
| 1,284 | 125,000 | .1647 | .0251 | .00549 | .00084 | |
| 1,335 | 130,000 | .1748 | .0292 | .00583 | .00097 | |
| 1,386 | 135,000 | .1880 | .0365 | .00627 | .00122 | |
| 1,438 | 140,000 | .2032 | .0440 | .00677 | .00147 | |
| 1,489 | 145,000 | .2180 | .0525 | .00727 | .00175 | |
| 1,541 | 150,000 | .2342 | .0605 | .00781 | .00202 | |
| 1,592 | 155,000 | .2542 | .0722 | .00847 | .00241 | |
| 1,643 | 160,000 | .2730 | .0870 | .00910 | .00290 | |
| 1,695 | 165,000 | .2960 | .1050 | .00987 | .00350 | |
| 1,746 | 170,000 | .3300 | .1300 | .01100 | .00433 | |
| 1,797 | 175,000 | .3670 | .1580 | .01223 | .00527 | |
| 1,991 | 194,000 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.61 in. in 30 in. = 2 per cent.
Dimensions at fracture, 0.075 by 0.075 in.
Sectional area, 0.00563 sq. in.
Contraction of area, 45.1 per cent.
Position of fracture, 13.35 in. inside gauge marks.
Appearance of fracture, fine silky, cup shaped.

From same coil as 8–A, or sample No. 8. This sample was annealed at 1,500° F. for one hour and allowed to cool slowly in furnace for about nine hours, annealed the second time at 1,500° F. for three hours and allowed to cool in furnace for about nine hours.

Marks, 8–B.

Dimensions, 0.1015 by 0.1014 in.

Sectional area, 0.01029 sq. in.

Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 51 | 5,000 | 0. | 0. | 0. | 0. | |
| 103 | 10,000 | .0062 | 0. | .00021 | 0. | |
| 205 | 20,000 | .0181 | 0. | .00060 | 0. | |
| 308 | 30,000 | .0306 | .0032 | .00102 | .00011 | |
| 359 | 35,000 | .0410 | .0091 | .00137 | .00030 | |
| 370 | 36,000 | .0490 | .0165 | .00163 | .00055 | |
| 380 | 37,000 | .0650 | .0318 | .00217 | .00106 | |
| 390 | 38,000 | .0870 | .0509 | .00290 | .00170 | |
| 401 | 39,000 | .1070 | .0730 | .00357 | .00243 | |
| 411 | 40,000 | .1300 | .0973 | .00433 | .00324 | |
| 421 | 41,000 | .1910 | .1540 | .00637 | .00513 | |
| 431 | 42,000 | .2450 | .2022 | .00817 | .00674 | |
| 442 | 43,000 | .2940 | .2530 | .00980 | .00843 | |
| 452 | 44,000 | .3270 | .2810 | .01090 | .00937 | |
| 462 | 45,000 | .3550 | .3070 | .01183 | .01023 | |
| 472 | 46,000 | .3760 | .3245 | .01253 | .01082 | |
| 483 | 47,000 | .4100 | .3655 | .01367 | .01218 | |
| 797 | 77,400 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 3.09 in. in 30 in. = 10.3 per cent.

Dimensions at fracture, 0.084 by 0.084 in.

Sectional area, 0.00706 sq. in.

Contraction of area, 31.4 per cent.

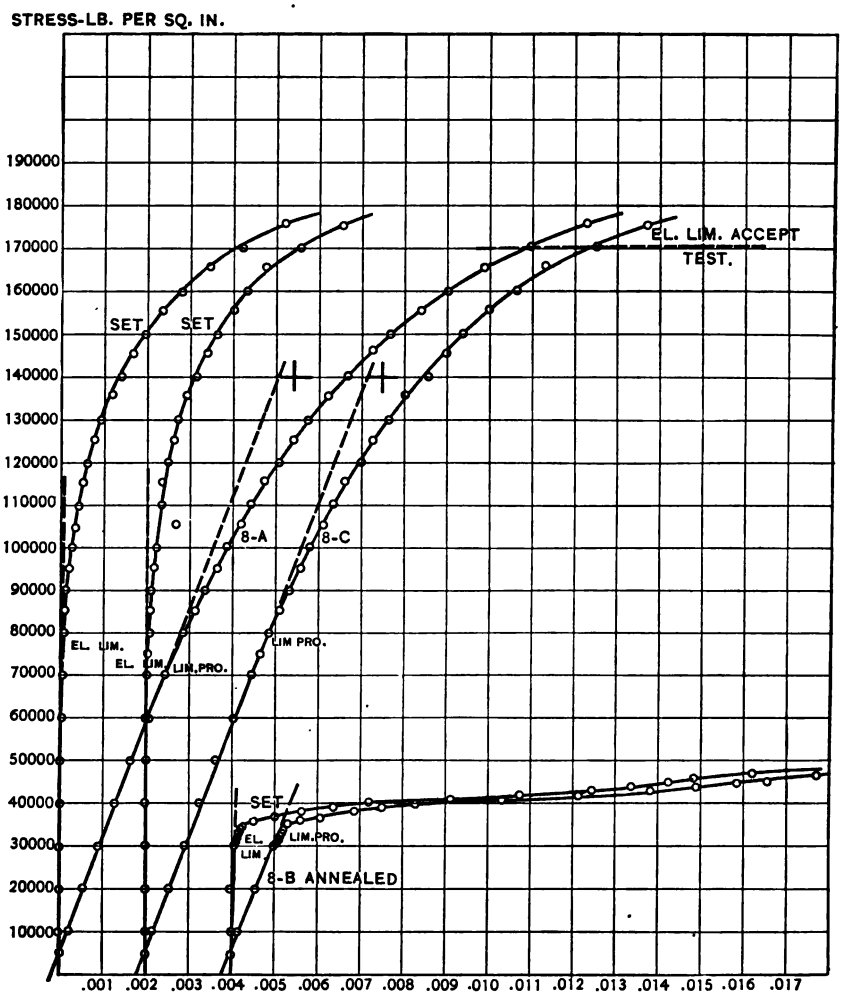
Position of fracture, 1.10 in. inside gauge marks.

Appearance of fracture, dull silky.

Marks, 8–C,—from same coil as 8–A.
Dimensions, 0.1013 by 0.1014 in.
Sectional area, 0.01027 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 51 | 5,000 | 0. | 0. | 0. | 0. | |
| 103 | 10,000 | .0060 | .0003 | .00020 | .00001 | |
| 205 | 20,000 | .0170 | .0002 | .00057 | .00001 | |
| 308 | 30,000 | .0282 | .0001 | .00094 | 0. | |
| 411 | 40,000 | .0392 | .0009 | .00131 | .00003 | |
| 514 | 50,000 | .0510 | .0009 | .00170 | .00003 | |
| 616 | 60,000 | .0630 | .0018 | .00210 | .00006 | |
| 719 | 70,000 | .0759 | .0025 | .00253 | .00008 | |
| 822 | 80,000 | .0882 | .0040 | .00294 | .00013 | |
| 873 | 85,000 | .0950 | .0050 | .00317 | .00017 | |
| 924 | 90,000 | .1020 | .0061 | .00340 | .00020 | |
| 976 | 95,000 | .1092 | .0073 | .00364 | .00024 | |
| 1,027 | 100,000 | .1165 | .0089 | .00388 | .00030 | |
| 1,078 | 105,000 | .1242 | (?) | .00414 | (?) | |
| 1,130 | 110,000 | .1323 | .0125 | .00441 | .00042 | |
| 1,181 | 115,000 | .1400 | .0140 | .00467 | .00047 | |
| 1,232 | 120,000 | .1510 | .0178 | .00503 | .00059 | |
| 1,284 | 125,000 | .1595 | .0210 | .00532 | .00070 | |
| 1,335 | 130,000 | .1720 | .0250 | .00573 | .00083 | |
| 1,386 | 135,000 | .1825 | .0300 | .00608 | .00100 | |
| 1,438 | 140,000 | .1980 | .0378 | .00660 | .00126 | |
| 1,489 | 145,000 | .2105 | .0440 | .00702 | .00147 | |
| 1,541 | 150,000 | .2250 | .0515 | .00750 | .00172 | |
| 1,592 | 155,000 | .2400 | .0620 | .00800 | .00207 | |
| 1,643 | 160,000 | .2620 | .0735 | .00873 | .00245 | |
| 1,695 | 165,000 | .2800 | .0860 | .00933 | .00287 | |
| 1,746 | 170,000 | .3150 | .1119 | .01050 | .00373 | |
| 1,797 | 175,000 | .3500 | .1391 | .01167 | .00464 | |
| 1,998 | 194,500 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.70 in. in 30 in. = 2.3 per cent.
Dimensions at fracture, 0.073 by 0.073 in.
Sectional area, 0.00533 sq. in.
Contraction of area, 48.1 per cent.
Position of fracture, 13.40 in. inside gauge marks.
Appearance of fracture, fine silky.




TENSILE TESTS OF SQUARE STEEL WIRE
FOR WINDING GUNS.
DETERMINATION OF ELASTIC LIMIT.

Sample No. 9. Reel 38. P. O. 8998. Diameter of coil in natural state, 19-in.

Marks, 9–A.

Dimensions, 0.1000 by 0.1000 in.

Sectional area, 0.01000 sq. in.

Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 50 | 5,000 | 0. | 0. | 0. | 0. | |
| 100 | 10,000 | .0060 | 0. | .00020 | 0. | |
| 200 | 20,000 | .0168 | −.0005 | .00056 | −.00002 | |
| 300 | 30,000 | .0270 | 0. | .00090 | 0. | |
| 400 | 40,000 | .0372 | −.0004 | .00124 | −.00001 | |
| 500 | 50,000 | .0480 | .0003 | .00160 | .00001 | |
| 600 | 60,000 | .0590 | 0. | .00197 | 0. | |
| 700 | 70,000 | .0700 | 0. | .00233 | 0. | |
| 800 | 80,000 | .0800 | 0. | .00267 | 0. | |
| 850 | 85,000 | .0858 | .0005 | .00286 | .00002 | |
| 900 | 90,000 | .0910 | −.0002 | .00303 | −.00001 | |
| 950 | 95,000 | .0970 | 0. | .00323 | 0. | |
| 1,000 | 100,000 | .1020 | .0005 | .00340 | .00002 | |
| 1,050 | 105,000 | .1070 | 0. | .00357 | 0. | |
| 1,100 | 110,000 | .1125 | 0. | .00375 | 0. | |
| 1,150 | 115,000 | .1182 | .0007 | .00394 | .00002 | |
| 1,200 | 120,000 | .1252 | .0010 | .00417 | .00003 | |
| 1,250 | 125,000 | .1318 | .0025 | .00439 | .00008 | |
| 1,300 | 130,000 | .1390 | .0031 | .00463 | .00010 | |
| 1,350 | 135,000 | .1452 | .0042 | .00484 | .00014 | |
| 1,400 | 140,000 | .1528 | .0060 | .00509 | .00020 | |
| 1,450 | 145,000 | .1605 | .0075 | .00535 | .00025 | |
| 1,500 | 150,000 | .1670 | .0095 | .00557 | .00032 | |
| 1,550 | 155,000 | .1745 | .0110 | .00582 | .00037 | |
| 1,600 | 160,000 | .1830 | .0130 | .00610 | .00043 | |
| 1,650 | 165,000 | .1908 | .0150 | .00636 | .00050 | |
| 1,700 | 170,000 | .2010 | .0181 | .00670 | .00060 | |
| 1,750 | 175,000 | .2087 | .0203 | .00696 | .00068 | |
| 1,800 | 180,000 | .2175 | .0240 | .00725 | .00080 | |
| 1,900 | 190,000 | .2380 | .0310 | .00793 | .00103 | |
| 2,000 | 200,000 | .2650 | .0440 | .00883 | .00147 | |
| 2,100 | 210,000 | .2970 | .0642 | .00990 | .00214 | |
| 2,200 | 220,000 | .3540 | .1030 | .01180 | .00310 | |
| 2,374 | 237,400 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.25 in. in 30 in. = .8 per cent.

When the fracture occurred the recoil put several small kinks in the wire.

Dimensions at fracture, 0.075 by 0.075 in

Sectional area, 0.00563 sq. in.

Contraction of area, 43.7 per cent.

Position of fracture, 11.65 in. inside gauge mark.

Appearance of fracture, fine silky, cup-shaped.

This sample was annealed at 1,500° F. for one hour and allowed to cool slowly in furnace for about nine hours; annealed the second time at 1,500° F. for three hours and allowed to cool in furnace for about nine hours.

Marks, 9–B,—from same coil as 9–A.

Dimensions, 0.1020 by 0.1030 in.

Sectional area, 0.01050 sq. in.

Sectional area used, 0.01000 sq. in., this being the sectional area of the unannealed wire from the same coil.

Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 50 | 5,000 | 0. | 0. | 0. | 0. | |
| 100 | 10,000 | .0062 | .0003 | .00021 | .00001 | |
| 150 | 15,000 | .0110 | .0003 | .00037 | .00001 | |
| 200 | 20,000 | .0172 | .0003 | .00057 | .00001 | |
| 250 | 25,000 | .0220 | .0009 | .00073 | .00003 | |
| 300 | 30,000 | .0285 | .0015 | .00095 | .00005 | |
| 310 | 31,000 | .0300 | .0025 | .00100 | .00008 | |
| 320 | 32,000 | .0310 | .0027 | .00103 | .00009 | |
| 330 | 33,000 | .0326 | .0032 | .00109 | .00011 | |
| 340 | 34,000 | .0337 | .0025 | .00112 | .00008 | |
| 350 | 35,000 | .0350 | .0038 | .00117 | .00013 | |
| 360 | 36,000 | .0370 | .0040 | .00123 | .00013 | |
| 370 | 37,000 | .0380 | .0049 | .00127 | .00016 | |
| 380 | 38,000 | .0400 | .0052 | .00133 | .00017 | |
| 390 | 39,000 | .0418 | .0063 | .00139 | .00021 | |
| 400 | 40,000 | .0440 | .0075 | .00147 | .00025 | |
| 410 | 41,000 | .0470 | .0095 | .00157 | .00032 | |
| 420 | 42,000 | .0500 | .0128 | .00167 | .00043 | |
| 430 | 43,000 | .0610 | .0215 | .00203 | .00072 | |
| 440 | 44,000 | .0730 | .0342 | .00243 | .00114 | |
| 450 | 45,000 | .0865 | .0445 | .00288 | .00148 | |
| 460 | 46,000 | .1180 | .0772 | .00393 | .00257 | |
| 470 | 47,000 | .1570 | .1140 | .00523 | .00380 | |
| 480 | 48,000 | .1800 | .1350 | .00600 | .00450 | |
| 490 | 49,000 | .2380 | .1890 | .00793 | .00630 | |
| 500 | 50,000 | .2640 | .2122 | .00880 | .00707 | |
| 510 | 51,000 | .2780 | .2245 | .00927 | .00748 | |
| 520 | 52,000 | .3010 | .2462 | .01003 | .00821 | |
| 530 | 53,000 | .3170 | .2612 | .01057 | .00871 | |
| 540 | 54,000 | .3420 | .2842 | .01140 | .00947 | |
| 550 | 55,000 | .3690 | .3087 | .01230 | .01029 | |
| 560 | 56,000 | .3940 | .3310 | .01313 | .01103 | |
| 903 | 90,300 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 2.20 in. in 30 in. = 7.3 per cent.

When the fracture occurred the recoil put several small kinks in the wire.

Dimensions at fracture, 0.082 by 0.082 in.

Sectional area, 0.00673 sq. in.

Contraction of area, 35.9 per cent.

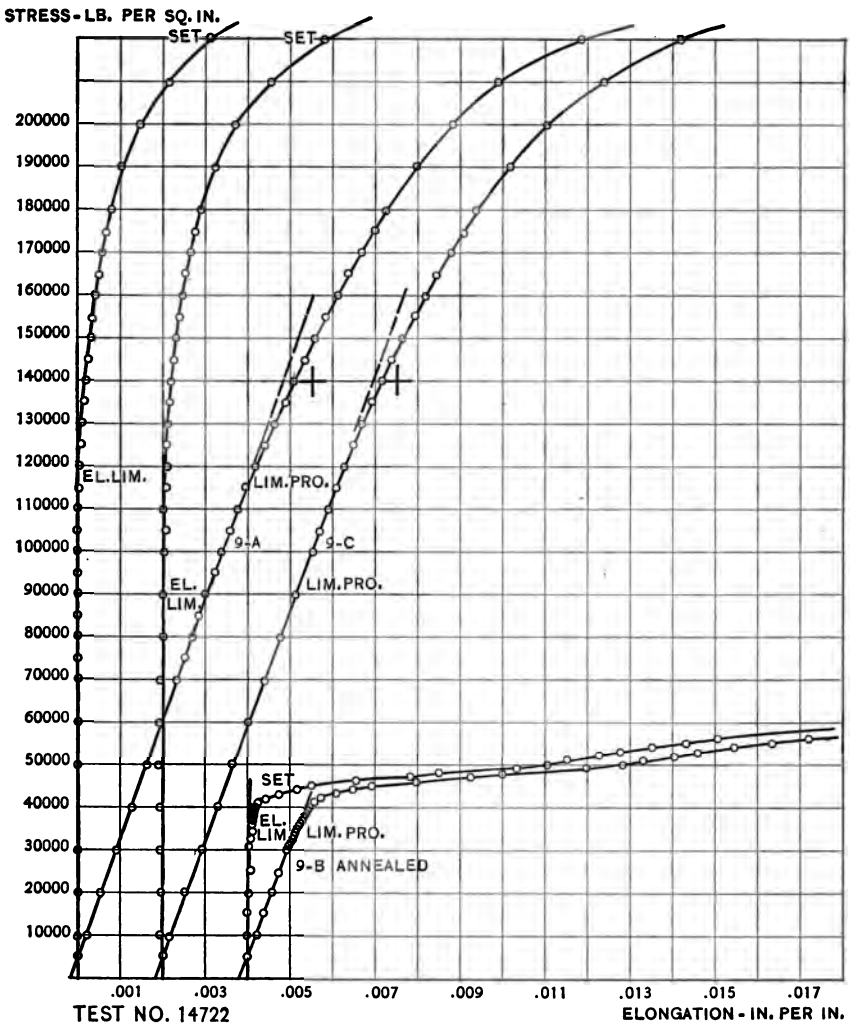
Position of fracture, 0.50 in. outside gauge marks.

Appearance of fracture, dull, silky.

From same coil as 9–A, or sample No. 9.
Marks, 9–C.
Dimensions, 0.1000 by 0.1000 in.
Sectional area, 0.01000 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 50 | 5,000 | 0. | 0. | 0. | 0. | |
| 100 | 10,000 | .0050 | −.0010 | .00017 | −.00003 | |
| 200 | 20,000 | .0155 | −.0008 | .00052 | −.00003 | |
| 300 | 30,000 | .0279 | −.0010 | .00093 | −.00003 | |
| 400 | 40,000 | .0380 | −.0010 | .00127 | −.00003 | |
| 500 | 50,000 | .0493 | −.0017 | .00164 | −.00006 | |
| 600 | 60,000 | .0600 | −.0010 | .00200 | −.00003 | |
| 700 | 70,000 | .0710 | −.0015 | .00237 | −.00005 | |
| 800 | 80,000 | .0822 | .0001 | .00274 | 0. | |
| 900 | 90,000 | .0930 | .0007 | .00310 | .00002 | |
| 1,000 | 100,000 | .1050 | .0017 | .00350 | .00006 | |
| 1,050 | 105,000 | .1110 | .0022 | .00370 | .00007 | |
| 1,100 | 110,000 | .1170 | .0020 | .00390 | .00007 | |
| 1,150 | 115,000 | .1220 | .0020 | .00407 | .00007 | |
| 1,200 | 120,000 | .1280 | .0030 | .00427 | .00010 | |
| 1,250 | 125,000 | .1348 | .0026 | .00449 | .00009 | |
| 1,300 | 130,000 | .1405 | .0040 | .00468 | .00013 | |
| 1,350 | 135,000 | .1469 | .0050 | .00490 | .00017 | |
| 1,400 | 140,000 | .1545 | .0061 | .00515 | .00020 | |
| 1,450 | 145,000 | .1610 | .0084 | .00537 | .00028 | |
| 1,500 | 150,000 | .1695 | .0100 | .00565 | .00033 | |
| 1,550 | 155,000 | .1773 | .0120 | .00591 | .00040 | |
| 1,600 | 160,000 | .1855 | .0140 | .00618 | .00047 | |
| 1,650 | 165,000 | .1930 | .0160 | .00643 | .00053 | |
| 1,700 | 170,000 | .2035 | .0200 | .00678 | .00067 | |
| 1,750 | 175,000 | .2112 | .0225 | .00704 | .00075 | |
| 1,800 | 180,000 | .2210 | .0270 | .00737 | .00090 | |
| 1,900 | 190,000 | .2438 | .0365 | .00813 | .00122 | |
| 2,000 | 200,000 | .2720 | .0510 | .00907 | .00170 | |
| 2,100 | 210,000 | .3120 | .0760 | .01040 | .00253 | |
| 2,200 | 220,000 | .3650 | .1140 | .01217 | .00380 | |
| 2,358 | 235,800 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.15 in. in 30 in. = 0.5 per cent.
When the fracture occurred, the recoil put several small kinks in the wire.
Dimensions at fracture, 0.080 by 0.080 in.
Sectional area, 0.00640 sq. in.
Contraction of area, 36 per cent.
Position of fracture, 1.10 in. outside gauge marks.
Appearance of fracture, fine silky.




TENSILE TESTS OF SQUARE STEEL WIRE FOR WINDING GUNS.
DETERMINATION OF ELASTIC LIMIT.

Sample No. 10, Reel 42. P. O. 8998. Diameter of coil in natural state, 17-in.
Marks, 10-A.
Dimensions, 0.1030 by 0.1030 in.
Sectional area, 0.01061 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 53 | 5,000 | 0. | 0. | 0. | 0. | |
| 106 | 10,000 | .0068 | .0008 | .00023 | .00003 | |
| 212 | 20,000 | .0180 | 0. | .00060 | 0. | |
| 318 | 30,000 | .0285 | .0003 | .00095 | .00001 | |
| 424 | 40,000 | .0400 | .0005 | .00133 | .00002 | |
| 531 | 50,000 | .0500 | .0003 | .00167 | .00001 | |
| 637 | 60,000 | .0610 | .0010 | .00203 | .00003 | |
| 743 | 70,000 | .0722 | .0010 | .00241 | .00003 | |
| 849 | 80,000 | .0841 | .0015 | .00280 | .00005 | |
| 902 | 85,000 | .0892 | ..... | .00297 | ..... | |
| 955 | 90,000 | .0948 | .0019 | .00316 | .00006 | |
| 1,008 | 95,000 | .1000 | .0014 | .00333 | .00005 | |
| 1,061 | 100,000 | .1053 | .0015 | .00351 | .00005 | |
| 1,114 | 105,000 | .1110 | .0020 | .00370 | .00007 | |
| 1,167 | 110,000 | .1162 | .0020 | .00387 | .00007 | |
| 1,220 | 115,000 | .1230 | .0025 | .00410 | .00008 | |
| 1,273 | 120,000 | .1291 | .0035 | .00430 | .00012 | |
| 1,326 | 125,000 | .1355 | .0050 | .00452 | .00017 | |
| 1,379 | 130,000 | .1437 | .0060 | .00479 | .00020 | |
| 1,432 | 135,000 | .1490 | .0067 | .00497 | .00026 | |
| 1,485 | 140,000 | .1568 | .0080 | .00523 | .00027 | |
| 1,538 | 145,000 | .1638 | .0102 | .00546 | .00034 | |
| 1,592 | 150,000 | .1710 | .0120 | .00570 | .00040 | |
| 1,645 | 155,000 | .1772 | .0125 | .00591 | .00042 | |
| 1,698 | 160,000 | .1849 | .0149 | .00616 | .00050 | |
| 1,751 | 165,000 | .1943 | .0170 | .00648 | .00057 | |
| 1,804 | 170,000 | .2020 | .0190 | .00673 | .00063 | |
| 1,857 | 175,000 | .2100 | .0215 | .00700 | .00072 | |
| 1,910 | 180,000 | .2190 | .0240 | .00730 | .00080 | |
| 1,963 | 185,000 | .2270 | .0273 | .00757 | .00091 | |
| 2,016 | 190,000 | .2360 | .0300 | .00787 | .00100 | |
| 2,069 | 195,000 | .2470 | .0342 | .00823 | .00114 | |
| 2,122 | 200,000 | .2580 | .0388 | .00860 | .00129 | |
| 2,228 | 210,000 | .2830 | .0500 | .00943 | .00167 | |
| 2,334 | 220,000 | .3190 | .0710 | .01063 | .00237 | |
| 2,440 | 230,000 | .3580 | .0980 | .01193 | .00327 | |
| 2,623 | 247,000 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.29 in. in 30 in. = 1 per cent.
Dimensions at fracture, 0.082 by 0.082 in.
Sectional area, 0.00673 sq. in.
Contraction of area, 36.5 per cent.
Position of fracture, 12.10 in. inside gauge marks.
Appearance of fracture, fine silky.

This sample was annealed at 1,500° F. for one hour, and allowed to cool slowly in furnace for about nine hours; annealed the second time at 1,500° F. for three hours and allowed to cool in furnace for about nine hours.

Marks, 10–B, from same coil as 10–A.

Dimensions, 0.1040 by 0.1040 in.

Sectional area, 0.01081 sq. in.

Sectional area used, 0.01061, this being the sectional area of the unannealed wire from the same coil.

Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 53 | 5,000 | 0. | 0. | 0. | 0. | |
| 106 | 10,000 | .0060 | .0005 | .00020 | .00002 | |
| 159 | 15,000 | .0120 | 0. | .00040 | 0. | |
| 212 | 20,000 | .0170 | 0. | .00057 | 0. | |
| 265 | 25,000 | .0225 | .0005 | .00075 | .00002 | |
| 318 | 30,000 | .0275 | .0009 | .00092 | .00003 | |
| 371 | 35,000 | .0332 | .0017 | .00111 | .00006 | |
| 382 | 36,000 | .0341 | .0020 | .00114 | .00007 | |
| 393 | 37,000 | .0360 | .0024 | .00120 | .00008 | |
| 403 | 38,000 | .0370 | .0032 | .00123 | .00011 | |
| 414 | 39,000 | .0385 | .0035 | .00128 | .00012 | |
| 424 | 40,000 | .0400 | .0041 | .00133 | .00014 | |
| 435 | 41,000 | .0450 | .0068 | .00150 | .00023 | |
| 446 | 42,000 | .0470 | .0088 | .00157 | .00029 | |
| 456 | 43,000 | .0518 | .0139 | .00173 | .00046 | |
| 467 | 44,000 | .0820 | .0430 | .00273 | .00143 | |
| 477 | 45,000 | .1150 | .0740 | .00383 | .00247 | |
| 488 | 46,000 | .1620 | .1210 | .00540 | .00403 | |
| 499 | 47,000 | .2200 | .1740 | .00733 | .00580 | |
| 509 | 48,000 | .2470 | .1960 | .00823 | .00653 | |
| 520 | 49,000 | .2650 | .2119 | .00883 | .00706 | |
| 531 | 50,000 | .2810 | .2275 | .00937 | .00758 | |
| 541 | 51,000 | .3050 | .2481 | .01017 | .00827 | |
| 552 | 52,000 | .3290 | .2710 | .01097 | .00903 | |
| 562 | 53,000 | .3520 | .2915 | .01173 | .00972 | |
| 573 | 54,000 | .3772 | .3133 | .01257 | .01044 | |
| 584 | 55,000 | .3970 | .3340 | .01323 | .01113 | |
| 941 | 87,000 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 2.50 in. in 30 in. = 8.4 per cent.

When the fracture occurred the recoil put several small kinks in the wire.

Dimensions at fracture, 0.089 by 0.089 in.

Sectional area, 0.00792 sq. in.

Contraction of area, 26.8 per cent.

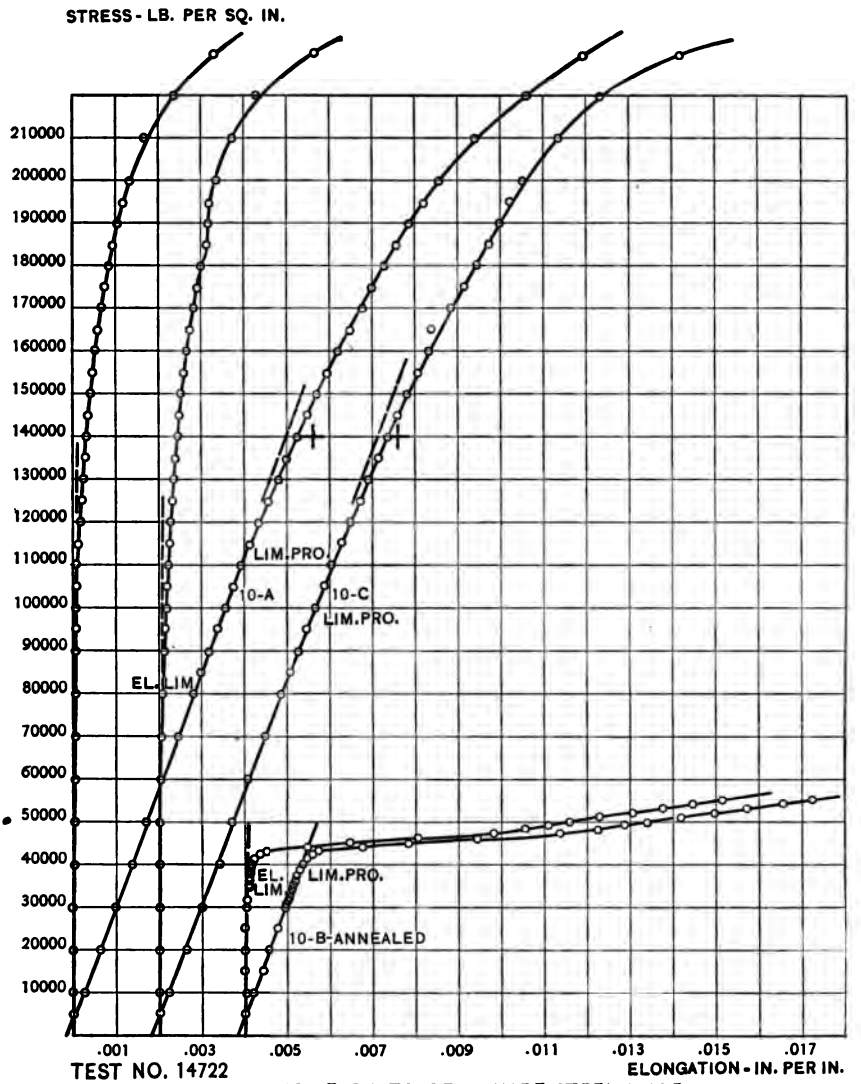
Position of fracture, 7.80 in. inside gauge marks.

Appearance of fracture, silky.

Marks, 10–C, from same coil as 10–A.
Dimensions, 0.1030 by 0.1030 in.
Sectional area, 0.01061 sq. in.
Gauged length, 30 in.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 53 | 5,000 | 0. | 0. | 0. | 0. | |
| 106 | 10,000 | .0060 | 0. | .00020 | 0. | |
| 212 | 20,000 | .0170 | 0. | .00057 | 0. | |
| 318 | 30,000 | .0290 | 0. | .00097 | 0. | |
| 424 | 40,000 | .0399 | .0003 | .00133 | .00001 | |
| 531 | 50,000 | .0508 | .0010 | .00169 | .00003 | |
| 637 | 60,000 | .0611 | .0011 | .00204 | .00004 | |
| 743 | 70,000 | .0739 | .0020 | .00246 | .00007 | |
| 849 | 80,000 | .0848 | .0030 | .00283 | .00010 | |
| 902 | 85,000 | .0908 | ..... | .00303 | ..... | |
| 955 | 90,000 | .0965 | .0040 | .00322 | .00013 | |
| 1,008 | 95,000 | .1020 | .0048 | .00340 | .00016 | |
| 1,061 | 100,000 | .1090 | .0050 | .00363 | .00017 | |
| 1,114 | 105,000 | .1150 | .0054 | .00383 | .00018 | |
| 1,167 | 110,000 | .1210 | .0061 | .00403 | .00020 | |
| 1,220 | 115,000 | .1270 | .0071 | .00423 | .00024 | |
| 1,273 | 120,000 | .1338 | .0080 | .00446 | .00027 | |
| 1,326 | 125,000 | .1400 | .0090 | .00467 | .00030 | |
| 1,379 | 130,000 | .1470 | .0100 | .00490 | .00033 | |
| 1,432 | 135,000 | .1532 | .0107 | .00511 | .00036 | |
| 1,485 | 140,000 | .1603 | .0124 | .00531 | .00041 | |
| 1,538 | 145,000 | .1678 | .0138 | .00559 | .00046 | |
| 1,592 | 150,000 | .1743 | .0150 | .00581 | .00050 | |
| 1,645 | 155,000 | .1822 | .0175 | .00607 | .00058 | |
| 1,698 | 160,000 | .1905 | .0191 | .00635 | .00064 | |
| 1,751 | 165,000 | .1907 | .0225 | .00636 | .00075 | |
| 1,804 | 170,000 | .2060 | .0245 | .00687 | .00082 | |
| 1,857 | 175,000 | .2140 | .0270 | .00713 | .00090 | |
| 1,910 | 180,000 | .2225 | .0300 | .00742 | .00100 | |
| 1,963 | 185,000 | .2323 | .0335 | .00774 | .00112 | |
| 2,016 | 190,000 | .2405 | .0352 | .00802 | .00117 | |
| 2,069 | 195,000 | .2475 | .0358 | .00825 | .00119 | |
| 2,122 | 200,000 | .2560 | .0390 | .00853 | .00130 | |
| 2,228 | 210,000 | .2810 | .0515 | .00937 | .00172 | |
| 2.334 | 220,000 | .3100 | .0680 | .01033 | .00227 | |
| 2,440 | 230,000 | .3670 | .1083 | .01223 | .00361 | |
| 2,637 | 248,100 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.24 in. in 30 in. = 0.8 per cent.
When the fracture occurred the recoil put several small kinks in the wire.
Dimensions at fracture, 0.084 by 0.084 in.
Sectional area, 0.00706 sq. in.
Contraction of area, 33.4 per cent.
Position of fracture, 0.70 in. inside gauge marks.
Appearance of fracture, fine silky.




TENSILE TESTS OF SQUARE STEEL WIRE
FOR WINDING GUNS
DETERMINATION OF ELASTIC LIMIT

# ORDNANCE SPECIMENS.

## TENSILE TESTS TO DETERMINE THE ELASTIC LIMIT.

## TEST 14886.

*TENSILE TESTS TO DETERMINE THE ELASTIC LIMIT.*

CAST STEEL NO. 1. HEAT NO. 3372 AND 3373. ARSENAL STEEL.

Marks, 9119.
Diameter, 0.503 in.
Sectional area, 0.1987 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 199 | 1,000 | 0. | 0. | |
| 993 | 5,000 | .00028 | .00014 | |
| 1,987 | 10,000 | .00066 | .00033 | |
| 2,980 | 15,000 | .00100 | .00050 | |
| 3,973 | 20,000 | .00135 | .00068 | |
| 4,965 | 25,000 | .00172 | .00086 | |
| 5,960 | 30,000 | .00209 | .00105 | Limit of proportionality. |
| 6,950 | 35,000 | .00284 | .00142 | |
| 7,150 | 36,000 | .00307 | .00154 | |
| 7,350 | 37,000 | .00332 | .00166 | |
| 7,550 | 38,000 | .00374 | .00187 | Yield point. |
| | | .00424 | .00212 | |
| 7,750 | 39,000 | .00556 | .00278 | |
| 7,940 | 40,000 | .01577 | .00789 | |

Extensometer reset to zero.

| | | | | |
|---|---|---|---|---|
| 199 | 1,000 | 0. | 0. | |
| 993 | 5,000 | .00025 | .00013 | |
| 1,987 | 10,000 | .00061 | .00030 | |
| 2,980 | 15,000 | .00098 | .00049 | |
| 3,973 | 20,000 | .00137 | .00069 | Limit of proportionality. |
| 4,965 | 25,000 | .00181 | .00091 | |
| 5,960 | 30,000 | .00227 | .00113 | |
| 6,950 | 35,000 | .00267 | .00133 | |
| 7,150 | 36,000 | .00281 | .00140 | |
| 7,350 | 37,000 | .00294 | .00147 | |
| 7,550 | 38,000 | .00310 | .00155 | |
| 7,750 | 39,000 | .00331 | .00165 | |
| 7,940 | 40,000 | .00365 | .00183 | Yield point. |
| 8,140 | 41,000 | .00581 | .00291 | |
| 8,340 | 42,000 | .00789 | .00394 | |
| 8,540 | 43,000 | .00946 | .00473 | |
| 8,740 | 44,000 | .01246 | .00623 | |
| 8,940 | 45,000 | .01470 | .00735 | |
| 15,400 | 77,000 | ..... | ..... | Tensile strength. |

Elongation after fracture: 0.44 in. in 2 in. = 22 per cent.
Elongation of inch sections: 0.25* 0.19 in.
Diameter at fracture: 0.43 in. Contraction of area: 27.4 per cent.
Position of fracture: 1.20 in. from the neck.
Appearance of fracture: Amorphous, trace of granulation.

## TEST 14887.

### CAST STEEL NO. 2. HEAT NO. 3374. ARSENAL STEEL.

Marks, 9121.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. gauge length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00024 | .00013 | |
| 2,000 | 10,000 | .00058 | .00029 | |
| 3,000 | 15,000 | .00094 | .00047 | |
| 4,000 | 20,000 | .00130 | .00065 | |
| 5,000 | 25,000 | .00165 | .00083 | |
| 6,000 | 30,000 | .00202 | .00101 | Limit of proportionality. |
| 7,000 | 35,000 | .00247 | .00123 | |
| 7,200 | 36,000 | .00257 | .00128 | |
| 7,400 | 37,000 | .00265 | .00133 | |
| 7,600 | 38,000 | .00272 | .00136 | |
| 7,800 | 39,000 | .00282 | .00141 | |
| 8,000 | 40,000 | .00298 | .00149 | |
| 8,200 | 41,000 | .00306 | .00153 | |
| 8,400 | 42,000 | .00320 | .00160 | |
| 8,600 | 43,000 | .00331 | .00166 | |
| 8,800 | 44,000 | .00347 | .00174 | |
| 9,000 | 45,000 | .00365 | .00182 | |
| 9,200 | 46,000 | .00379 | .00189 | |
| 9,400 | 47,000 | .00404 | .00202 | |
| 9,600 | 48,000 | .00432 | .00216 | Yield point. |
| 9,700 | 48,500 | .00565 | .00282 | |
| 9,800 | 49,000 | .00980 | .00490 | |
| 200 | 1,000 | .00967 | .00484 | Set. |

Extensometer reset to zero.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00027 | .00014 | |
| 2,000 | 10,000 | .00063 | .00032 | |
| 3,000 | 15,000 | .00101 | .00051 | |
| 4,000 | 20,000 | .00141 | .00071 | Limit of proportionality. |
| 5,000 | 25,000 | .00180 | .00090 | |
| 6,000 | 30,000 | .00224 | .00112 | |
| 7,000 | 35,000 | .00267 | .00134 | |
| 7,200 | 36,000 | .00276 | .00138 | |
| 7,400 | 37,000 | .00285 | .00143 | |
| 7,600 | 38,000 | .00293 | .00147 | |
| 7,800 | 39,000 | .00304 | .00152 | |
| 8,000 | 40,000 | .00317 | .00159 | |
| 8,200 | 41,000 | .00321 | .00160 | |
| 8,400 | 42,000 | .00332 | .00166 | |
| 8,600 | 43,000 | .00342 | .00171 | |
| 8,800 | 44,000 | .00351 | .00175 | |
| 9,000 | 45,000 | .00363 | .00182 | |
| 9,200 | 46,000 | .00374 | .00187 | |
| 9,400 | 47,000 | .00387 | .00194 | |
| 9,600 | 48,000 | .00405 | .00203 | |
| 9,800 | 49,000 | .00439 | .00220 | |
| 10,000 | 50,000 | .00490 | .00245 | Yield point. |
| 10,200 | 51,000 | .00681 | .00341 | |
| 10,400 | 52,000 | .00872 | .00436 | |
| 10,600 | 53,000 | .01105 | .00553 | |
| 10,800 | 54,000 | .01304 | .00652 | |
| 10,900 | 54,500 | .01478 | .00739 | |
| 15,300 | 76,500 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.06* 0.06 in.
Diameter at fracture, 0.49 in.
Position of fracture, 0.30 in. from the neck.
Appearance of fracture, amorphous 80 per cent, fine granular 20 per cent.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 30,000 lb. per sq. in. |
| Yield point | 48,000 lb. per sq. in. |
| Tensile strength | 76,500 lb. per sq. in. |
| Modulus of elasticity | 29,000,000 lb. per sq. in. |
| Elongation in 2 in. | 6.0 per cent. |
| Contraction of area | 5.7 per cent. |
| After stressing to 49,000 lb. per sq. in.: | |
| Limit of proportionality | 20,000 lb. per sq. in. |
| Yield point | 50,000 lb. per sq. in. |
| Modulus of elasticity | 27,600,000 lb. per sq. in. |

## TEST 14890.

### CAST STEEL NO. 2 AND 3. HEAT NO. 3350. ARSENAL STEEL.

Marks, 8754.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Berry's extensometer used, K2.
Edelmann's thermo-electric apparatus for determining elastic limit used.

| Applied loads. | | Elongations. | | Galvanometer—Deflections. | Remarks. |
|---|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | | |
| *Lb.* | *Lb.* | *In.* | *In.* | *Mm.* | |
| 200 | 1,000 | 0. | 0. | 0 | When readings were started the galvanometer was swinging very slowly in the cooling or negative direction. |
| 1,000 | 5,000 | .0002 | .00010 | − 1 | |
| 2,000 | 10,000 | .0006 | .00030 | − 2 | |
| 3,000 | 15,000 | .0009 | .00045 | − 4 | |
| 4,000 | 20,000 | .0013 | .00065 | − 5 | |
| 5,000 | 25,000 | .0016 | .00080 | − 5 | |
| 6,000 | 30,000 | .0020 | .00100 | − 6 | |
| 7,000 | 35,000 | .0024 | .00120 | − 7 | |
| 7,200 | 36,000 | .0025 | .00125 | − 8 | Limit of proportionality. |
| 7,400 | 37,000 | .0026 | .00130 | − 8 | |
| 7,600 | 38,000 | .0026 | .00130 | − 8 | |
| 7,800 | 39,000 | .0027 | .00135 | − 9 | |
| 8,000 | 40,000 | .0028 | .00140 | − 9 | |
| 8,200 | 41,000 | .0030 | .00150 | −10 | |
| 8,400 | 42,000 | .0030 | .00150 | −10 | |
| 8,600 | 43,000 | .0031 | .00155 | −11 | |
| 8,800 | 44,000 | .0033 | .00165 | −11 | |
| 9,000 | 45,000 | .0036 | .00180 | −11 | Yield point, elastic limit by galvanometer. |
| 9,200 | 46,000 | .0174 | .00870 | − 8 | |
| 9,400 | 47,000 | .0187 | .00935 | − 8 | |
| 9,600 | 48,000 | .0200 | .01000 | − 8 | |
| 9,800 | 49,000 | .0220 | .01100 | − 9 | |
| 10,000 | 50,000 | .0240 | .01200 | − 9 | |
| 11,000 | 55,000 | .0330 | .01650 | − 8 | |
| 12,000 | 60,000 | .0460 | .02300 | − 5 | |
| 13,000 | 65,000 | ..... | ..... | − 2 | |
| 14,000 | 70,000 | ..... | ..... | + 3, +6 | |
| 17,000 | 85,000 | ..... | ..... | ..... | Tensile strength. |

Elongations of inch sections, 0.20*, 0.25* in.
Diameter at fracture, 0.44 in.
Position of fracture, 1.30 in. from the neck.
Appearance of fracture, amorphous 85 per cent, granular 15 per cent.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 36,000-lb. per sq. in. |
| Elastic limit by galvanometer | 45,000-lb. per sq. in. |
| Yield point | 45,000-lb. per sq. in. |
| Tensile strength | 85,000-lb. per sq. in. |
| Elongation | 22.5 per cent. |
| Contraction of area | 24.0 per cent. |

## TEST 14891.

CAST STEEL NO. 2 AND 3. HEAT NO. 3369. ARSENAL STEEL.

**Marks**, 9085.
**Diameter**, 0.505 in.
**Sectional area**, 0.20 sq. in.
**Gauged length**, 2 in.
**Berry extensometer used**, K2.
**Edelmann's thermo-electric apparatus for determining elastic limit used.**

| Applied loads. | | Elongations. | | Galvanometer readings. | Remarks. |
|---|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | | |
| *Lb.* | *Lb.* | *In.* | *In.* | *Mm.* | |
| 200 | 1,000 | 0. | 0. | 0 | When readings were started the galvanometer was swinging slowly in a heating or positive direction. |
| 1,000 | 5,000 | .0002 | .00010 | 1 | |
| 2,000 | 10,000 | .0004 | .00020 | 1 | |
| 3,000 | 15,000 | .0008 | .00040 | 2 | |
| 4,000 | 20,000 | .0012 | .00060 | 3 | |
| 5,000 | 25,000 | .0016 | .00080 | 3 | |
| 6,000 | **20,000 | .0020 | .00100 | 2 | Limit of proportionality. |
| 7,000 | 35,000 | .0036 | .00180 | 3 | Yield point. |
| 7,200 | 36,000 | .0064 | .00320 | 4 | |
| 7,400 | 37,000 | .0096 | .00480 | 5 | |
| 7,600 | 38,000 | .0133 | .00665 | 5 | |
| 7,800 | 39,000 | .0156 | .00780 | 5 | |
| 8,000 | 40,000 | .0174 | .00870 | 5 | |
| 8,200 | 41,000 | .0195 | .00975 | 5 | |
| 8,400 | 42,000 | .0213 | .01065 | 5 | |
| 8,600 | 43,000 | .0236 | .01180 | 5 | |
| 8,800 | 44,000 | .0258 | .01290 | 5 | |
| 9,000 | 45,000 | .0280 | .01400 | 6 | |
| 9,200 | 46,000 | .0316 | .01580 | 6 | |
| 9,400 | 47,000 | .0330 | .01650 | 6 | |
| 9,600 | 48,000 | .0354 | .01770 | 6 | |
| 9,800 | 49,000 | .0374 | .01870 | 6 | |
| 10,000 | 50,000 | .0410 | .02050 | 6 | |
| 11,000 | 55,000 | ..... | ..... | 5 | |
| 12,000 | 60,000 | ..... | ..... | 9 | |
| 13,000 | 65,000 | ..... | ..... | 17 | |
| 14,000 | 70,000 | ..... | ..... | 25 | |
| 15,400 | 77,000 | ..... | ..... | ..... | Tensile strength. |

**Elongation of inch sections**: 0.29*, 0.16 in.
**Diameter at fracture**: 0.43 in.
**Position of fracture**: 0.90 in. from the neck.
**Appearance of fracture**: Amorphous 60 per cent, granular 40 per cent.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 30,000 lb. per sq. in. |
| **Elastic limit by galvanometer | 30,000 lb. per sq. in. |
| Yield point | 35,000 lb. per sq. in. |
| Tensile strength | 77,000 lb. per sq. in. |
| Elongation in 2 in. | 22.5 per cent. |
| Contraction of area | 27.4 per cent. |

## TEST 14888.

CAST STEEL NO. 3. HEAT NO. 3356 A2 TI. ARSENAL STEEL.

Marks, 8864–2.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00026 | .00013 | |
| 2,000 | 10,000 | .00058 | .00029 | |
| 3,000 | 15,000 | .00093 | .00047 | |
| 4,000 | 20,000 | .00131 | .00066 | |
| 5,000 | 25,000 | .00166 | .00083 | |
| 6,000 | 30,000 | .00201 | .00101 | |
| 7,000 | 35,000 | .00236 | .00118 | |
| 7,200 | 36,000 | .00244 | .00122 | |
| 7,400 | 37,000 | .00251 | .00125 | |
| 7,600 | 38,000 | .00259 | .00130 | Limit of proportionality. |
| 7,800 | 39,000 | .00266 | .00133 | |
| 8,000 | 40,000 | .00277 | .00138 | |
| 8,200 | 41,000 | .00284 | .00142 | |
| 8,400 | 42,000 | .00293 | .00147 | |
| 8,600 | 43,000 | .00302 | .00151 | |
| 8,800 | 44,000 | .00314 | .00157 | |
| 9,000 | 45,000 | .00330 | .00165 | Yield point. |
| Load fell to— | | | | |
| 8,486 | 42,430 | .00464 | .00232 | |
| 8,486 | 42,430 | .00504 | .00252 | |
| 8,600 | 43,000 | .00514 | .00257 | |
| 8,800 | 44,000 | .00540 | .00270 | |
| 9,000 | 45,000 | .00739 | .00370 | |
| 9,200 | 46,000 | {.01495<br>{.01944 | .00748<br>.00972 | |
| 200 | 1,000 | .01572 | .00786 | Set. |

Extensometer reset to zero.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00026 | .00013 | |
| 2,000 | 10,000 | .00063 | .00032 | |
| 3,000 | 15,000 | .00099 | .00049 | |
| | 17,000 | | | Limit of proportionality. |
| 4,000 | 20,000 | .00140 | .00070 | |
| 5,000 | 25,000 | .00180 | .00090 | |
| 6,000 | 30,000 | .00223 | .00112 | |
| 7,000 | 35,000 | .00268 | .00134 | |
| 7,200 | 36,000 | .00278 | .00139 | |
| 7,400 | 37,000 | .00285 | .00143 | |
| 7,600 | 38,000 | .00294 | .00147 | |
| 7,800 | 39,000 | .00303 | .00151 | |
| 8,000 | 40,000 | .00315 | .00158 | |
| 8,200 | 41,000 | .00329 | .00165 | |
| 8,400 | 42,000 | .00335 | .00168 | |
| 8,600 | 43,000 | .00349 | .00175 | |
| 8,800 | 44,000 | .00360 | .00180 | |
| 9,000 | 45,000 | .00381 | .00191 | |
| 9,200 | 46,000 | .00409 | .00204 | |
| 200 | 1,000 | | | Set. |
| 9,400 | 47,000 | .00472 | .00236 | Yield point. |
| 9,600 | 48,000 | .00648 | .00324 | |
| 9,800 | 49,000 | .00880 | .00440 | |
| 10,000 | 50,000 | .01114 | .00557 | |
| 10,200 | 51,000 | .01371 | .00686 | |
| 10,400 | 52,000 | .01615 | .00808 | |
| 10,600 | 53,000 | .01869 | .00935 | |
| 16,600 | 83,000 | | | Tensile strength. |

Elongation of inch sections, 0.12 0.18* in.
Diameter at fracture, 0.46 in.
Position of fracture, 0.50 in. from the neck.
Appearance of fracture, amorphous.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 38,000 lb. per sq. in. |
| Yield point | 45,000 lb. per sq. in. |
| Tensile strength | 83,000 lb. per sq. in. |
| Modulus of elasticity | 28,800,000 lb. per sq. in. |
| Elongation in 2 in. | 15.0 per cent. |
| Contraction of area | 16.9 per cent. |
| After stressing to 46,000 lb. per sq. in.: | |
| Limit of proportionality | 17,000 lb. per sq. in. |
| Yield point | 47,000 lb. per sq. in. |
| Modulus of elasticity | 28,500,000 lb. per sq. in. |

## TEST 14889.

CAST STEEL NO. 3. HEAT NO. 3359 A2 TI. ARSENAL STEEL.

Marks, 8937–2.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2 in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00023 | .00012 | |
| 2,000 | 10,000 | .00061 | .00031 | |
| 3,000 | 15,000 | .00098 | .00049 | |
| 4,000 | 20,000 | .00133 | .00067 | |
| 5,000 | 25,000 | .00168 | .00084 | |
| 6,000 | 30,000 | .00204 | .00102 | |
| 7,000 | 35,000 | .00240 | .00120 | |
| 7,200 | 36,000 | .00248 | .00124 | |
| 7,400 | 37,000 | .00258 | .00129 | |
| 7,600 | 38,000 | .00263 | .00132 | |
| 7,800 | 39,000 | .00268 | .00134 | |
| 8,000 | 40,000 | .00277 | .00139 | |
| 8,200 | 41,000 | .00286 | .00143 | |
| 8,400 | 42,000 | .00292 | .00146 | |
| 8,600 | 43,000 | .00301 | .00150 | |
| 8,800 | 44,000 | .00311 | .00155 | |
| 9,000 | 45,000 | .00316 | .00158 | |
| 9,200 | 46,000. | .00331 | .00166 | |
| 9,400 | 47,000 | .00332 | .00166 | |
| 9,600 | 48,000 | .00339 | .00170 | Limit of proportionality. |
| 9,800 | 49,000 | .00346 | .00173 | |
| 10,000 | 50,000 | .00356 | .00178 | |
| 10,200 | 51,000 | .00371 | .00186 | Yield point. |
| 9,372 | 46,860 | .00608 | .00304 | |
| 9,400 | 47,000 | .00612 | .00306 | |
| 9,600 | 48,000 | .00624 | .00312 | |
| 9,800 | 49,000 | .00697 | .00349 | |
| 9,900 | 49,500 | .01436 | .00718 | |
| 9,600 | 48,000 | .01471 | .00736 | |
| 9,800 | 49,000 | .01992 | .00996 | |

Extensometer reset to zero.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00026 | .00013 | |
| 2,000 | 10,000 | .00064 | .00032 | |
| 3,000 | 15,000 | .00101 | .00050 | Limit of proportionality. |
| 4,000 | 20,000 | .00141 | .00071 | |
| 5,000 | 25,000 | .00180 | .00090 | |
| 6,000 | 30,000 | .00223 | .00112 | |
| 7,000 | 35,000 | .00263 | .00131 | |
| 7,200 | 36,000 | .00273 | .00137 | |
| 7,400 | 37,000 | .00281 | .00140 | |
| 7,600 | 38,000 | .00288 | .00144 | |
| 7,800 | 39,000 | .00298 | .00149 | |
| 8,000 | 40,000 | .00307 | .00153 | |
| 8,200 | 41,000 | .00318 | .00159 | |
| 8,400 | 42,000 | .00339 | .00170 | |
| 8,600 | 43,000 | .00342 | .00171 | |
| 8,800 | 44,000 | .00351 | .00175 | |
| 9,000 | 45,000 | .00364 | .00182 | |
| 9,200 | 46,000 | .00372 | .00186 | |
| 9,400 | 47,000 | .00408<br>.00689 | .00204<br>.00345 | Yield point. |
| 9,600 | 48,000 | .00750 | .00375 | |
| 9,800 | 49,000 | .00829 | .00415 | |
| 10,000 | 50,000 | .00946 | .00473 | |
| 10,200 | 51,000 | .01204 | .00602 | |
| 10,400 | 52,000 | .01428 | .00714 | |
| 10,600 | 53,000 | .01685 | .00843 | |
| 10,800 | 54,000 | .01950 | .00975 | |
| 16,100 | 80,500 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.21, 0.25* in.
Diameter at fracture, 0.43 in.
Position of fracture, 1.20 in. from the neck.
Appearance of fracture, amorphous.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 48,000 lb. per sq. in. |
| Yield point | 51,000 lb. per sq. in. |
| Tensile strength | 80,500 lb. per sq. in. |
| Modulus of elasticity | 28,300,000 lb. per sq. in. |
| Elongation in 2 in | 23.0 per cent. |
| Contraction of area | 27.4 per cent. |
| After stressing to 49,000 lb. per sq. in.: | |
| Limit of proportionality | 15,000 lb. per sq. in. |
| Yield point | 47,000 lb. per sq. in. |
| Modulus of elasticity | 27,500,000 lb. per sq. in. |

## TEST 14881.

### FORGED STEEL "D." ARSENAL STEEL.

Marks, 163 F–3.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00027 | .00014 | |
| 2,000 | 10,000 | .00061 | .00031 | |
| 3,000 | 15,000 | .00096 | .00048 | |
| 4,000 | 20,000 | .00134 | .00067 | |
| 5,000 | 25,000 | .00169 | .00085 | |
| 6,000 | 30,000 | .00204 | .00102 | |
| 7,000 | 35,000 | .00241 | .00121 | |
| 8,000 | 40,000 | .00276 | .00138 | |
| 8,200 | 41,000 | .00289 | .00145 | |
| 8,400 | 42,000 | .00293 | .00147 | |
| 8,600 | 43,000 | .00302 | .00151 | |
| 8,800 | 44,000 | .00310 | .00155 | |
| 9,000 | 45,000 | .00316 | .00158 | |
| 9,200 | 46,000 | .00324 | .00162 | |
| 9,400 | 47,000 | .00330 | .00165 | |
| 9,600 | 48,000 | .00336 | .00168 | |
| 9,800 | 49,000 | .00345 | .00173 | |
| 10,000 | 50,000 | .00350 | .00175 | |
| 10,200 | 51,000 | .00360 | .00180 | |
| 10,400 | 52,000 | .00367 | .00184 | |
| 10,600 | 53,000 | .00372 | .00186 | |
| 10,800 | 54,000 | .00374 | .00187 | |
| 11,000 | 55,000 | .00388 | .00194 | |
| 11,200 | 56,000 | .00397 | .00199 | |
| 11,400 | 57,000 | .00407 | .00203 | |
| 11,600 | 58,000 | .00410 | .00205 | |
| 11,800 | 59,000 | .00417 | .00208 | |
| 12,000 | 60,000 | .00428 | .00214 | |
| 12,200 | 61,000 | .00432 | .00216 | |
| 12,400 | 62,000 | .00438 | .00219 | |
| 12,600 | 63,000 | .00448 | .00224 | |
| 12,800 | 64,000 | .00453 | .00227 | |
| 13,000 | 65,000 | .00468 | .00234 | |
| 13,200 | 66,000 | .00467 | .00233 | |
| 13,400 | 67,000 | .00473 | .00237 | |
| 13,600 | 68,000 | .00482 | .00241 | |
| 13,800 | 69,000 | .00492 | .00246 | |
| 14,000 | 70,000 | .00498 | .00249 | |
| 14,200 | 71,000 | .00506 | .00253 | |
| 14,400 | 72,000 | .00512 | .00256 | |
| 14,600 | 73,000 | .00520 | .00260 | |
| 14,800 | 74,000 | .00527 | .00265 | |
| 15,000 | 75,000 | .00532 | .00266 | |
| 15,200 | 76,000 | .00542 | .00271 | |
| 15,400 | 77,000 | .00550 | .00275 | |
| 15,600 | 78,000 | .00556 | .00278 | |
| 15,800 | 79,000 | .00563 | .00282 | |
| 16,000 | 80,000 | .00574 | .00287 | |
| 16,200 | 81,000 | .00581 | .00290 | |
| 16,400 | 82,000 | .00582 | .00291 | |
| 16,600 | 83,000 | .00596 | .00298 | |
| 16,800 | 84,000 | .00600 | .00300 | |
| 17,000 | 85,000 | .00612 | .00306 | |
| 17,200 | 86,000 | .00616 | .00308 | |
| 17,400 | 87,000 | .00623 | .00312 | |
| 17,600 | 88,000 | .00635 | .00318 | |
| 17,800 | 89,000 | .00643 | .00322 | |
| 18,000 | 90,000 | .00650 | .00325 | |
| 18,200 | 91,000 | .00657 | .00328 | |
| 18,400 | 92,000 | .00667 | .00333 | Limit of proportionality. |
| 18,600 | 93,000 | .00674 | .00337 | |

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 18,800 | 94,000 | .00684 | .00342 | |
| 19,000 | 95,000 | .00694 | .00347 | |
| 19,200 | 96,000 | .00708 | .00354 | |
| 19,400 | 97,000 | .00717 | .00358 | |
| 19,600 | 98,000 | .00724 | .00362 | |
| 19,800 | 99,000 | .00738 | .00369 | |
| 20,000 | 100,000 | .00749 | .00375 | |
| 20,200 | 101,000 | .00799 | .00399 | |
| 20,400 | 102,000 | .00800 | .00400 | |
| 20,600 | 103,000 | .00814 | .00407 | |
| 20,800 | 104,000 | .00824 | .00412 | |
| 21,000 | 105,000 | .00844 | .00422 | |
| 21,200 | 106,000 | .00877 | .00439 | |
| 21,400 | 107,000 | .00896 | .00448 | |
| 21,600 | 108,000 | .00922 | .00461 | |
| 28,700 | 143,500 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.24*, 0.05 in.
Diameter at fracture, 0.37 in.
Position of fracture, 0.60 in. from the neck.
Appearance of fracture, fine silky.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 92,000 lb. per sq. in. |
| Tensile strength | 143,500 lb. per sq. in. |
| Modulus of elasticity | 27,700,000 lb. per sq. in. |
| Elongation in 2 in | 14.5 per cent. |
| Contraction of area | 46.2 per cent. |

## TEST 14884.

### FORGED STEEL "D." ARSENAL STEEL.

Marks, 226 F–2.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00023 | .00012 | |
| 2,000 | 10,000 | .00061 | .00030 | |
| 3,000 | 15,000 | .00101 | .00051 | |
| 4,000 | 20,000 | .00133 | .00066 | |
| 5,000 | 25,000 | .00169 | .00084 | |
| 6,000 | 30,000 | .00204 | .00102 | |
| 7,000 | 35,000 | .00240 | .00120 | |
| 8,000 | 40,000 | .00276 | .00138 | |
| 9,000 | 45,000 | .00319 | .00160 | |
| 10,000 | 50,000 | .00346 | .00173 | |
| 11,000 | 55,000 | .00383 | .00192 | |
| 12,000 | 60,000 | .00421 | .00211 | |
| 13,000 | 65,000 | .00454 | .00227 | |
| 14,000 | 70,000 | .00490 | .00245 | |
| 14,400 | 72,000 | .00505 | .00252 | |
| 14,800 | 74,000 | .00520 | .00260 | |
| 15,200 | 76,000 | .00535 | .00267 | |
| 15,600 | 78,000 | .00548 | .00274 | |
| 16,000 | 80,000 | .00565 | .00282 | |
| 16,400 | 82,000 | .00580 | .00290 | |
| 16,800 | 84,000 | .00592 | .00296 | |
| 17,200 | 86,000 | .00606 | .00303 | |
| 17,600 | 88,000 | .00622 | .00311 | |
| 18,000 | 90,000 | .00637 | .00318 | |
| 18,400 | 92,000 | .00654 | .00327 | |
| 18,800 | 94,000 | .00664 | .00332 | |
| 19,200 | 96,000 | .00679 | .00340 | |
| 19,600 | 98,000 | .00693 | .00346 | |
| 20,000 | 100,000 | .00707 | .00354 | |
| 20,400 | 102,000 | .00722 | .00361 | |
| 20,800 | 104,000 | .00738 | .00369 | |
| 21,200 | 106,000 | .00756 | .00378 | |
| 21,600 | 108,000 | .00769 | .00384 | |
| 22,000 | 110,000 | .00783 | .00392 | |
| 22,400 | 112,000 | .00800 | .00400 | |
| 22,800 | 114,000 | .00814 | .00407 | |
| 23,200 | 116,000 | .00828 | .00414 | |
| 23,600 | 118,000 | .00842 | .00421 | |
| 24,000 | 120,000 | .00859 | .00430 | |
| 24,400 | 122,000 | .00874 | .00437 | |
| 24,800 | 124,000 | .00889 | .00445 | Limit of proportionality. |
| 25,200 | 126,000 | .00905 | .00453 | |
| 25,600 | 128,000 | .00922 | .00461 | |
| 26,000 | 130,000 | .00939 | .00470 | |
| 26,400 | 132,000 | .00962 | .00481 | |
| 26,800 | 134,000 | .00981 | .00491 | |
| 27,200 | 136,000 | .01005 | .00503 | |
| 27,600 | 138,000 | .01044 | .00522 | |
| 28,000 | 140,000 | .01066 | .00533 | |
| 28,400 | 142,000 | .01131 | .00566 | |
| 200 | 1,000 | .00118 | .00059 | Set. |

Extensometer set to zero.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00033 | .00017 | |
| 2,000 | 10,000 | .00065 | .00032 | |
| 3,000 | 15,000 | .00101 | .00051 | |
| 4,000 | 20,000 | .00135 | .00067 | |
| 5,000 | 25,000 | .00173 | .00086 | |
| 6,000 | 30,000 | .00209 | .00105 | |
| 7,000 | 35,000 | .00243 | .00121 | |
| 8,000 | 40,000 | .00281 | .00141 | |
| 9,000 | 45,000 | .00318 | .00160 | |
| 10,000 | 50,000 | .00360 | .00180 | |
| 11,000 | 55,000 | .00384 | .00192 | |
| 12,000 | 60,000 | .00424 | .00212 | |
| 13,000 | 65,000 | .00465 | .00233 | |
| 14,000 | 70,000 | .00500 | .00250 | |
| 14,800 | 74,000 | .00523 | .00262 | |
| 15,600 | 78,000 | .00555 | .00277 | |
| 16,400 | 82,000 | .00581 | .00291 | |
| 17,200 | 86,000 | .00612 | .00306 | |
| 18,000 | 90,000 | .00645 | .00323 | |
| 18,800 | 94,000 | .00670 | .00335 | |
| 19,600 | 98,000 | .00698 | .00349 | |
| 20,400 | 102,000 | .00728 | .00364 | |
| 21,200 | 106,000 | .00758 | .00379 | |
| 22,000 | 110,000 | .00787 | .00394 | |
| 22,800 | 114,000 | .00820 | .00410 | |
| 23,600 | 118,000 | .00847 | .00423 | |
| 24,400 | 122,000 | .00878 | .00439 | Limit of proportionality. |
| 25,200 | 126,000 | .00910 | .00455 | |
| 26,000 | 130,000 | .00940 | .00470 | |
| 26,800 | 134,000 | .00970 | .00485 | |
| 27,600 | 138,000 | .01004 | .00502 | |
| 28,400 | 142,000 | .01406 | .00523 | |
| 29,200 | 146,000 | .01204 | .00602 | |
| 200 | 1,000 | .00148 | .00074 | Set. |
| 33,300 | 166,500 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.05, 0.22* in.
Diameter at fracture, 0.39 in. from the neck.
Position of fracture, 0.80 in. from the neck.
Appearance of fracture, fine silky.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 124,000 lb. per sq. in. |
| Modulus of elasticity | 28,000,000 lb. per sq. in. |
| Tensile strength | 166,500 lb. per sq. in. |
| Elongation in 2 in | 13.5 per cent. |
| Contraction of area | 40.3 per cent. |
| After stressing to 142,000 lb. per sq. in.: | |
| Limit of proportionality | 122,000 lb. per sq. in |
| Modulus of elasticity | 27,800,000 lb. per sq. in |

## TEST 14868.

FORGED STEEL NO. 5, NAVY. ARSENAL STEEL.

Marks, 247 F.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Berry extensometer used.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .0002 | .00010 | |
| 2,000 | 10,000 | .0006 | .00030 | |
| 3,000 | 15,000 | .0009 | .00045 | |
| 4,000 | 20,000 | .0012 | .00060 | |
| 5,000 | 25,000 | .0016 | .00080 | |
| 6,000 | 30,000 | .0020 | .00100 | |
| 7,000 | 35,000 | .0023 | .00115 | |
| 8,000 | 40,000 | .0026 | .00130 | |
| 8,200 | 41,000 | .0027 | .00135 | |
| 8,400 | 42,000 | .0028 | .00140 | |
| 8,600 | 43,000 | .0028 | .00140 | |
| 8,800 | 44,000 | .0029 | .00145 | |
| 9,000 | 45,000 | .0030 | .00150 | Limit of proportionality. |
| | | .0042 | .00210 | Yield point. |
| 16,600 | 83,000 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.36*, 0.15 in.
Diameter at fracture, 0.36 in.
Position of fracture, 0.60 in. from the neck.
Appearance of fracture, silky.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 45,000 lb. per sq. in. |
| Yield point | 45,000 lb. per sq. in. |
| Tensile strength | 83,000 lb. per sq. in. |
| Elongation in 2 in | 25.5 per cent. |
| Contraction of area | 49.1 per cent. |

## TEST 14871.

### FORGED STEEL NO. 5, NAVY. ARSENAL STEEL.

Marks, 240–F.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00028 | .00014 | |
| 2,000 | 10,000 | .00063 | .00032 | |
| 3,000 | 15,000 | .00097 | .00049 | |
| 4,000 | 20,000 | .00132 | .00066 | |
| 5,000 | 25,000 | .00166 | .00083 | |
| 6,000 | 30,000 | .00202 | .00101 | |
| 7,000 | 35,000 | .00239 | .00120 | |
| | 37,000 | ..... | ..... | Limit of proportionality. |
| 8,000 | 40,000 | .00285 | .00143 | |
| 8,200 | 41,000 | .00308 | .00154 | |
| 8,400 | 42,000 | .00548 | .00274 | Yield point. |
| 8,600 | 43,000 | .00830 | .00415 | |
| 18,200 | 91,000 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.25, 0.28* in.
Diameter at fracture, 0.38 in.
Position of fracture, 1.35 in. from the neck.
Appearance of fracture, dull silky.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 37,000 lb. per sq. in. |
| Yield point | 42,000 lb. per sq. in. |
| Tensile strength | 91,000 lb. per sq. in. |
| Modulus of elasticity | 28,500,000 lb. per sq. in. |
| Elongation in 2 in | 26.5 per cent. |
| Contraction of area | 43.3 per cent. |

## TEST 14882.

### FORGED STEEL NO. 5 NAVY. ARSENAL STEEL.

Marks, 211 F.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2 in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *In.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00028 | .00014 | |
| 2,000 | 10,000 | .00065 | .00033 | |
| 3,000 | 15,000 | .00101 | .00051 | |
| 4,000 | 20,000 | .00135 | .00067 | |
| 5,000 | 25,000 | .00168 | .00084 | |
| 6,000 | 30,000 | .00206 | .00103 | |
| 7,000 | 35,000 | .00251 | .00125 | |
| 7,200 | 36,000 | .00254 | .00127 | |
| 7,400 | 37,000 | .00251 | .00126 | |
| 7,600 | 38,000 | .00270 | .00135 | |
| 7,800 | 39,000 | .00872 | .00436 | Limit of proportionality. |
| | | .01495 | .00748 | Yield point. |

Extensometer set to zero.

| | | | | |
|---|---|---|---|---|
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00027 | .00014 | |
| 2,000 | 10,000 | .00068 | .00034 | |
| 3,000 | 15,000 | .00106 | .00053 | |
| 4,000 | 20,000 | .00145 | .00072 | Limit of proportionality. |
| 5,000 | 25,000 | .00189 | .00094 | |
| 6,000 | 30,000 | .00236 | .00118 | |
| 7,000 | 35,000 | .00281 | .00140 | |
| 7,200 | 36,000 | .00296 | .00148 | |
| 7,400 | 37,000 | .00310 | .00155 | |
| 7,600 | 38,000 | .00323 | .00162 | |
| 7,800 | 39,000 | .00349 | .00174 | |
| 8,000 | 40,000 | .00403 | .00201 | Yield point. |
| 8,200 | 41,000 | .00590 | .00295 | |
| 8,400 | 42,000 | .00739 | .00370 | |
| 8,600 | 43,000 | .00914 | .00457 | |
| 8,800 | 44,000 | .01046 | .00523 | |
| 16,400 | 82,000 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.25, 0.12 in.
Diameter at fracture, 0.43 in.
Position of fracture, 0.65 in. from the neck.
Appearance of fracture, lamellar.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 39,000 lb. per sq. in. |
| Yield point | 39,000 lb. per sq. in. |
| Tensile strength | 82,000 lb. per sq. in. |
| Modulus of elasticity | 27,600,000 lb. per sq. in. |
| Elongation in 2 in. | 18.5 per cent. |
| Contraction of area | 27.4 per cent. |
| After stressing to 39,000 lb. per sq. in.: | |
| Limit of proportionality | 20,000 lb. per sq. in. |
| Yield point | 40,000 lb. per sq. in. |
| Modulus of elasticity | 26,000,000 lb. per sq. in. |

## TEST 14883.

### FORGED STEEL NO. 5 NAVY. ARSENAL STEEL.

**Marks, 212 F.**
**Diameter, 0.505 in.**
**Sectional area, 0.20 sq. in.**
**Gaged length, 2 in.**
**Berry extensometer used, K2.**
**Edelmann thermo-electric apparatus for determining elastic limit used.**

| Applied loads. | | Elongations. | | Galvanometer. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | Reading. | Deflection. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *Mm.* | *In.* | |
| 200 | 1,000 | 0. | 0. | 70 | 0 | |
| 1,000 | 5,000 | .0003 | .00015 | 67 | 3 | |
| 2,000 | 10,000 | .0009 | .00045 | 64 | 6 | |
| 3,000 | 15,000 | .0013 | .00065 | 64 | 6 | |
| 4,000 | 20,000 | .0016 | .00080 | 66 | 4 | |
| 5,000 | 25,000 | .0020 | .00100 | 68 | 2 | |
| 6,000 | 30,000 | .0023 | .00115 | 69 | 1 | |
| 7,000 | 35,000 | .0026 | .00130 | 71 | −1 | |
| 7,200 | 36,000 | .0028 | .00140 | 73 | −3 | |
| 7,400 | 37,000 | .0028 | .00140 | 74 | −4 | |
| 7,600 | 38,000 | .0029 | .00145 | 75 | −5 | |
| 7,800 | 39,000 | .0029 | .00145 | 75 | −5 | Limit of proportionality. |
| 8,000 | 40,000 | .0031 | .00155 | 77 | −7 | Yield point. |
| 8,200 | 41,000 | .0280 | .01400 | 73 | −3 | |
| 8,400 | 42,000 | .0288 | .01440 | 75 | −5 | |
| 8,600 | 43,000 | .0297 | .01485 | 76 | −6 | |
| 8,800 | 44,000 | .0317 | .01585 | 77 | −7 | |
| 9,000 | 45,000 | .0340 | .01700 | 79 | −9 | Elastic limit by galvanometer. |
| 10,000 | 50,000 | .0442 | .0221 | 78 | −8 | |
| 11,000 | 55,000 | ..... | ..... | 75 | −5 | |
| 12,000 | 60,000 | ..... | ..... | 72 | −2 | |
| 13,000 | 65,000 | ..... | ..... | 62 | 8 | |
| 14,000 | 70,000 | ..... | ..... | 39 | 31 | |
| 15,200 | 76,000 | ..... | ..... | ..... | ..... | Tensile strength. |

**Elongation of inch sections, 0.10, 0.37* in.**
**Diameter at fracture, 0.37 in.**
**Position of fracture, 0.70 in. from the neck.**
**Appearance of fracture, Silky.**

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 39,000 lb. per sq. in. |
| Elastic limit by galvanometer | 45,000 lb. per sq. in. |
| Yield point | 40,000 lb. per sq. in. |
| Tensile strength | 76,000 lb. per sq. in. |
| Elongation in 2 in. | 23.5 per cent. |
| Contraction of area | 46.2 per cent. |

## TEST 14899.

### FORGED STEEL NO. 5 NAVY. ARSENAL STEEL.

Marks, 1526 F.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00026 | .00013 | |
| 2,000 | 10,000 | .00060 | .00030 | |
| 3,000 | 15,000 | .00094 | .00047 | |
| 4,000 | 20,000 | .00127 | .00064 | |
| 5,000 | 25,000 | .00164 | .00082 | |
| 6,000 | 30,000 | .00198 | .00099 | |
| 6,200 | 31,000 | .00207 | .00104 | |
| 6,400 | 32,000 | .00213 | .00107 | |
| 6,600 | 33,000 | .00219 | .00110 | |
| 6,800 | 34,000 | .00227 | .00113 | |
| 7,000 | 35,000 | .00235 | .00118 | |
| 7,200 | 36,000 | .00243 | .00122 | |
| 7,400 | 37,000 | .00247 | .00124 | |
| 7,600 | 38,000 | .00256 | .00128 | |
| 7,800 | 39,000 | .00262 | .00131 | |
| 8,000 | 40,000 | .00269 | .00135 | |
| 8,200 | 41,000 | .00277 | .00139 | |
| 8,400 | 42,000 | .00285 | .00143 | |
| 8,600 | 43,000 | .00290 | .00145 | |
| 8,800 | 44,000 | .00298 | .00149 | |
| 9,000 | 45,000 | .00306 | .00153 | |
| 9,200 | 46,000 | .00314 | .00157 | Limit of proportionality. |
| 9,400 | 47,000 | .00321 | .00161 | |
| 9,600 | 48,000 | .00335 | .00167 | |
| 9,800 | 49,000 | .00372 | .00186 | Yield point. |
| 9,282 | 46,410 | .01826 | .00913 | |
| 200 | 1,000 | .01614 | .00807 | Set. |

Extensometer reset to zero.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00022 | .00011 | |
| 2,000 | 10,000 | .00057 | .00028 | |
| 3,000 | 15,000 | .00094 | .00047 | |
| 4,000 | 20,000 | .00128 | .00064 | |
| 5,000 | 25,000 | .00164 | .00082 | Limit of proportionality. |
| 6,000 | 30,000 | .00203 | .00101 | |
| 6,400 | 32,000 | .00217 | .00108 | |
| 6,800 | 34,000 | .00233 | .00117 | |
| 7,200 | 36,000 | .00252 | .00126 | |
| 7,600 | 38,000 | .00263 | .00132 | |
| 8,000 | 40,000 | .00279 | .00140 | |
| 8,400 | 42,000 | .00297 | .00149 | |
| 8,800 | 44,000 | .00315 | .00157 | |
| 9,000 | 45,000 | .00326 | .00163 | |
| 9,200 | 46,000 | .00355 | .00177 | |
| 9,400 | 47,000 | .00540 | .00270 | Yield point. |
| 16,200 | 81,000 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.34*, 0.22 in.
Diameter at fracture, 0.37 in.
Position of fracture, 1.10 in. from the neck.
Appearance of fracture, fine silky, open longitudinal seam in the stem.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 46,000 lb. per sq. in. |
| Yield point | 49,000 lb. per sq. in. |
| Tensile strength | 81,000 lb. per sq. in. |
| Modulus of elasticity | 28,800,000 lb. per sq. in. |
| Elongation in 2 in | 28.0 per cent. |
| Contraction of area | 46.2 per cent. |
| After stressing to 49,000 lb. per sq. in.: | |
| Limit of proportionality | 25,000 lb. per sq. in. |
| Yield point | 47,000 lb. per sq. in. |
| Modulus of elasticity | 28,400,000 lb. per sq. in. |

## TEST 14900.

### FORGED STEEL NO. 5 NAVY. ARSENAL STEEL.

Marks, 1540 F.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00027 | .00013 | |
| 2,000 | 10,000 | .00061 | .00030 | |
| 3,000 | 15,000 | .00098 | .00048 | |
| 4,000 | 20,000 | .00130 | .00065 | |
| 5,000 | 25,000 | .00164 | .00082 | |
| 6,000 | 30,000 | .00201 | .00101 | |
| 6,200 | 31,000 | .00209 | .00105 | |
| 6,400 | 32,000 | .00214 | .00107 | |
| 6,600 | 33,000 | .00222 | .00111 | |
| 6,800 | 34,000 | .00228 | .00114 | |
| 7,000 | 35,000 | .00237 | .00118 | |
| 7,200 | 36,000 | .00244 | .00122 | |
| 7,400 | 37,000 | .00251 | .00125 | |
| 7,600 | 38,000 | .00257 | .00128 | |
| 7,800 | 39,000 | .00264 | .00132 | |
| 8,000 | 40,000 | .00272 | .00136 | |
| 8,200 | 41,000 | .00280 | .00140 | |
| 8,400 | 42,000 | .00285 | .00143 | |
| 8,600 | 43,000 | .00293 | .00147 | |
| 8,800 | 44,000 | .00302 | .00151 | |
| 9,000 | 45,000 | .00309 | .00155 | |
| 9,200 | 46,000 | .00318 | .00159 | |
| 9,400 | 47,000 | .00323 | .00162 | Limit of proportionality. |
| 9,546 | 47,730 | ..... | ..... | Yield point. |
| 9,200 | 46,000 | .00663 | .00331 | |
| 9,400 | 47,000 | .00805 | .00403 | |
| 9,600 | 48,000 | .01536 | .00768 | |
| 200 | 1,000 | .01452 | .00726 | Set. |

Extensometer reset to zero.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00019 | .00010 | |
| 2,000 | 10,000 | .00055 | .00027 | |
| 3,000 | 15,000 | .00090 | .00045 | |
| 4,000 | 20,000 | .00128 | .00064 | |
| 5,000 | 25,000 | .00165 | .00083 | Limit of proportionality. |
| 6,000 | 30,000 | .00210 | .00105 | |
| 6,400 | 32,000 | .00223 | .00111 | |
| 6,800 | 34,000 | .00238 | .00119 | |
| 7,200 | 36,000 | .00256 | .00128 | |
| 7,600 | 38,000 | .00271 | .00135 | |
| 8,000 | 40,000 | .00288 | .00144 | |
| 8,400 | 42,000 | .00308 | .00154 | |
| 8,600 | 43,000 | .00317 | .00159 | |
| 8,800 | 44,000 | .00326 | .00163 | |
| 9,000 | 45,000 | .00340 | .00170 | |
| 9,200 | 46,000 | .00415 | .00208 | Yield point. |
| 9,400 | 47,000 | .00697 | .00349 | |
| 9,600 | 48,000 | .00872 | .00436 | |
| 17,000 | 85,000 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.26*, 0.31* in.
Diameter at fracture, 0.35 in.
Position of fracture, 1.20 in. from the neck.
Appearance of fracture, fine silky, cup-shaped.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 47,000 lb. per sq. in. |
| Yield point | 47,730 lb. per sq. in. |
| Tensile strength | 85,000 lb. per sq. in. |
| Modulus of elasticity | 28,200,000 lb. per sq. in. |
| Elongation in 2 in. | 28.5 per cent. |
| Contraction of area | 51.9 per cent. |
| After stressing to 47,730 lb. per sq. in.: | |
| Limit of proportionality | 25,000 lb. per sq. in. |
| Yield point | 46,000 lb. per sq. in. |
| Modulus of elasticity | 27,500,000 lb. per sq. in. |

## TEST 14885.

### FORGED STEEL NO. 3. ARSENAL STEEL.

Marks, 273–F.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Berry's extensometer used, K2.
Edelmann thermo-electric apparatus for determining elastic limit used.

| Applied loads. | | Elongation. | | Galvanometer reading. | Remarks. |
|---|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | |
| 200 | 1,000 | | | | |
| 1,000 | 5,000 | 0. | 0. | 0 | |
| 2,000 | 10,000 | .0004 | .00020 | − 1 | |
| 3,000 | 15,000 | .0009 | .00045 | − 2 | |
| 4,000 | 20,000 | .0013 | .00065 | − 3 | |
| 5,000 | 25,000 | .0017 | .00085 | − 4 | |
| 6,000 | 30,000 | .0021 | .00105 | − 5 | |
| 6,400 | 32,000 | .0022 | .00110 | − 5 | |
| 6,800 | 34,000 | .0023 | .00115 | − 6 | |
| 7,200 | 36,000 | .0025 | .00125 | − 6 | |
| 7,600 | 38,000 | .0026 | .00130 | − 7 | |
| 7,800 | 39,000 | .0027 | .00135 | − 8 | |
| 8,000 | 40,000 | .0028 | .00140 | − 9 | |
| 8,200 | 41,000 | .0028 | .00140 | − 9 | |
| 8,600 | 43,000 | .0030 | .00150 | − 9 | |
| 8,800 | 44,000 | .0031 | .00155 | − 9 | |
| 9,000 | 45,000 | .0032 | .00160 | − 9 | |
| 9,200 | 46,000 | .0032 | .00160 | − 9 | |
| 9,400 | 47,000 | .0034 | .00170 | −10 | |
| 9,800 | 49,000 | .0034 | .00170 | −11 | |
| 10,000 | 50,000 | .0035 | .00175 | −12 | |
| 10,200 | 51,000 | .0036 | .00180 | −12 | |
| 10,600 | 53,000 | .0037 | .00185 | −13 | |
| 10,800 | 54,000 | .0038 | .00190 | −13 | |
| 11,000 | 55,000 | .0039 | .00195 | −13 | |
| 11,300 | 56,500 | .0050 | .00250 | −13 | Limit of proportionality.<br>Yield point.<br>Elastic limit by galvanometer. |
| 11,800 | 59,000 | .0190 | .00950 | −10 | |
| 13,000 | 65,000 | .0350 | .01750 | − 6 | |
| 15,000 | 75,000 | .0430 | .02150 | − 4 | |
| 16,000 | 80,000 | ..... | ..... | − 2 | |
| 17,000 | 85,000 | ..... | ..... | + 2 | |
| 18,000 | 90,000 | ..... | ..... | + 9 | |
| 21,200 | 106,000 | ..... | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.10, 0.26* in.
Diameter at fracture, 0.38 in.
Position of fracture, 0.60 in. from the neck.
Appearance of fracture, silky.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 56,500 lb. per sq. in. |
| Elastic limit by galvanometer | 56,500 lb. per sq. in. |
| Yield point | 56,500 lb. per sq. in. |
| Tensile strength | 106,000 lb. per sq. in. |
| Elongation in 2 in | 18.0 per cent. |
| Contraction of area | 43.3 per cent. |

## TEST 14866.

### FORGED STEEL NO. 2.

Marks, 255–F.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Inspectors' extensometer used on 2-in. length.

| Applied loads. | | In gauged length. | | Per inch. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | Elongation. | Set. | Elongation. | Set. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | 0. | ..... | |
| 1,000 | 5,000 | .0002 | ..... | .00010 | ..... | |
| 2,000 | 10,000 | .0005 | ..... | .00025 | ..... | |
| 3,000 | 15,000 | .0008 | ..... | .00040 | ..... | |
| 4,000 | 20,000 | .0011 | .0001 | .00055 | .00005 | |
| 5,000 | 25,000 | .0014 | ..... | .00070 | ..... | |
| 6,000 | 30,000 | .0017 | .0001 | .00085 | .00005 | Limit of proportionality. |
| 7,000 | 35,000 | .0021 | ..... | .00105 | ..... | |
| 8,000 | 40,000 | .0025 | .0002 | .00125 | .0001 | |
| 8,200 | 41,000 | .0026 | ..... | .00130 | ..... | |
| 8,400 | 42,000 | .0027 | ..... | .00135 | ..... | |
| 8,600 | 43,000 | .0033–.0200 | ..... | .00165–.0100 | ..... | Yield point. |
| 8,800 | 44,000 | .0260 | ..... | .0130 | ..... | |
| 9,000 | 45,000 | .0280 | ..... | .0140 | ..... | |
| 16,000 | 80,000 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.16, 0.39* in.
Diameter at fracture, 0.36 in.
Position of fracture, 0.85 in. from the neck.
Appearance of fracture, silky.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 30,000 lb. per sq. in. |
| Elastic limit | 30,000 lb. per sq. in. |
| Yield point | 43,000 lb. per sq. in. |
| Tensile strength | 80,000 lb. per sq. in. |
| Elongation in 2 in | 27.5 per cent. |
| Contraction of area | 49.1 per cent. |

## TEST 14894.

### FORGED STEEL NO. 2. ARSENAL STEEL.

Marks, 234–F.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00025 | .00013 | |
| 2,000 | 10,000 | .00060 | .00030 | |
| 3,000 | 15,000 | .00093 | .00047 | |
| 4,000 | 20,000 | .00127 | .00064 | |
| 5,000 | 25,000 | .00165 | .00083 | Limit of proportionality. |
| 6,000 | 30,000 | .00201 | .00101 | |
| 6,200 | 31,000 | .00206 | .00103 | |
| 6,400 | 32,000 | .00213 | .00107 | |
| 6,600 | 33,000 | .00221 | .00111 | |
| 6,800 | 34,000 | .00229 | .00115 | |
| 7,000 | 35,000 | .00236 | .00118 | |
| 7,200 | 36,000 | .00248 | .00124 | |
| 7,400 | 37,000 | .00262 | .00131 | |
| 7,600 | 38,000 | .00272 | .00136 | Yield point. |
| 7,800 | 39,000 | .00399 | .00199 | |
| 8,000 | 40,000 | .00631 | .00316 | |
| 8,200 | 41,000 | .00839 | .00419 | |
| 8,400 | 42,000 | .01046 | .00523 | |
| 8,600 | 43,000 | .01588 | .00794 | |
| 200 | 1,000 | .01272 | .00636 | Set. |

Extensometer reset to zero.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00023 | .00012 | |
| 2,000 | 10,000 | .00057 | .00029 | |
| 3,000 | 15,000 | .00095 | .00047 | |
| ..... | 17,000 | ..... | ..... | Limit of proportionality. |
| 4,000 | 20,000 | .00132 | .00066 | |
| 5,000 | 25,000 | .00169 | .00085 | |
| 6,000 | 30,000 | .00212 | .00106 | |
| 6,200 | 31,000 | .00221 | .00111 | |
| 6,400 | 32,000 | .00226 | .00113 | |
| 6,600 | 33,000 | .00235 | .00118 | |
| 6,800 | 34,000 | .00242 | .00121 | |
| 7,000 | 35,000 | .00251 | .00125 | |
| 7,200 | 36,000 | .00259 | .00130 | |
| 7,400 | 37,000 | .00266 | .00133 | |
| 7,600 | 38,000 | .00276 | .00138 | |
| 7,800 | 39,000 | .00285 | .00143 | |
| 8,000 | 40,000 | .00298 | .00149 | |
| 8,200 | 41,000 | .00312 | .00156 | |
| 8,400 | 42,000 | .00323 | .00162 | |
| 8,600 | 43,000 | .00341 | .00171 | |
| 8,800 | 44,000 | .00388 | .00194 | Yield point. |
| 9,000 | 45,000 | .00577 | .00289 | |
| 9,200 | 46,000 | .00747 | .00374 | |
| 9,400 | 47,000 | .00967 | .00484 | |
| 200 | 1,000 | .00612 | .00306 | Set. |
| 16,500 | 82,500 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.19, 0.36* in.
Diameter at fracture, 0.33 in.
Position of fracture, 1.25 in. from the neck.
Appearance of fracture, fine silky.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 25,000 lb. per sq. in. |
| Yield point | 38,000 lb. per sq. in. |
| Tensile strength | 82,500 lb. per sq. in. |
| Modulus of elasticity | 29,700,000 lb. per sq. in. |
| Elongation in 2 in | 27.5 per cent. |
| Contraction of area | 57.2 per cent. |
| After stressing to 43,000 lb. per sq. in.: | |
| Limit of proportionality | 17,000 lb. per sq. in. |
| Yield point | 44,000 lb. per sq. in. |
| Modulus of elasticity | 28,700,000 lb. per sq. in. |

## TEST 14869.

### GUN STEEL. TRUNNION HOOP 6-IN. GUN.

Marks, 1743 F–C.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | 0. | 0. | |
| 2,000 | 10,000 | .0002 | .00010 | |
| 3,000 | 15,000 | .0006 | .00030 | |
| 4,000 | 20,000 | .0010 | .00050 | |
| 5,000 | 25,000 | .0014 | .00070 | |
| 6,000 | 30,000 | .0018 | .00090 | |
| 7,000 | 35,000 | .0022 | .00110 | |
| 8,000 | 40,000 | .0025 | .00125 | |
| 8,200 | 41,000 | .0026 | .00130 | |
| 8,400 | 42,000 | .0027 | .00135 | |
| 8,600 | 43,000 | .0028 | .00140 | Limit of proportionality. |
| 8,800 | 44,000 | .0029 | .00145 | |
| 9,000 | 45,000 | .0030 | .00150 | |
| 9,200 | 46,000 | .0032 | .00160 | Yield point. |
| | | .0068 | .00340 | |
| 9,400 | 47,000 | .0135 | .00675 | |
| 9,600 | 48,000 | .0190 | .00950 | |
| 10,000 | 50,000 | .0218 | .01090 | |
| 10,400 | 52,000 | .0240 | .01200 | |
| 10,800 | 54,000 | .0270 | .01350 | |
| 11,200 | 56,000 | .0315 | .01575 | |
| 12,000 | 60,000 | .0380 | .01900 | |
| 18,500 | 92,500 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.29*, 0.24 in.
Diameter at fracture, 0.38 in.
Position of fracture, at middle of length.
Appearance of fracture, silky.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 43,000 lb. per sq. in. |
| Yield point | 46,000 lb. per sq. in. |
| Tensile strength | 92,500 lb. per sq. in. |
| Elongation in 2 in | 26.5 per cent. |
| Contraction of area | 43.3 per cent. |

## TEST 14872.

### STUDENT OFFICERS' TEST. ARSENAL STEEL.

Marks, INGOT 26.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00022 | .00011 | |
| 2,000 | 10,000 | .00058 | .00029 | |
| 3,000 | 15,000 | .00098 | .00049 | |
| 4,000 | 20,000 | .00130 | .00065 | |
| 5,000 | 25,000 | .00163 | .00081 | |
| 6,000 | 30,000 | .00200 | .00100 | |
| 7,000 | 35,000 | .00240 | .00120 | |
| 8,000 | 40,000 | .00277 | .00138 | |
| 8,200 | 41,000 | .00288 | .00144 | |
| 8,400 | 42,000 | .00294 | .00147 | |
| 8,600 | 43,000 | .00308 | .00154 | |
| 8,800 | 44,000 | .00309 | .00155 | Limit of proportionality |
| 9,000 | 45,000 | .00317 | .00159 | |
| 9,200 | 46,000 | .00332 | .00166 | Yield point. |
| 9,400 | 47,000 | .00548 | .00274 | |
| 16,400 | 82,000 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.32*, 0.19 in.
Diameter at fracture, 0.41 in.
Position of fracture, 1 in. from the neck
Appearance of fracture, dull silky.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 44,000 lb. per sq. in. |
| Yield point | 46,000 lb. per sq. in. |
| Tensile strength | 82,000 lb. per sq. in. |
| Modulus of elasticity | 27,500,000 lb. per sq. in. |
| Elongation in 2 in | 25.5 per cent. |
| Contraction of area | 34.0 per cent. |

## TEST 14870.

### STUDENT OFFICERS' TEST. EX. 25. ARSENAL STEEL.

Marks, 1450F–25.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged lengths, 2 in.
Berry's extensometer used, K2.
Edelmann's thermo-electric apparatus for determining elastic limit used.

| Applied loads. | | Elongations. | | Galvanometer. | | Remarks. |
|---|---|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | Reading. | Deflection. | |
| *Lb.* | *Lb.* | *In.* | *In.* | *Mm.* | *Mm.* | |
| 200 | 1,000 | 0. | 0. | 57 | 0 | |
| 1,000 | 5,000 | .0001 | .00005 | 57 | 0 | |
| 2,000 | 10,000 | .0003 | .00015 | 57 | 0 | |
| 3,000 | 15,000 | .0007 | .00035 | 58 | −1 | |
| 4,000 | 20,000 | .0011 | .00055 | 58 | −1 | |
| 5,000 | 25,000 | .0014 | .00070 | 59 | −2 | |
| 6,000 | 30,000 | .0018 | .00090 | 59 | −2 | |
| 7,000 | 35,000 | .0021 | .00105 | 59 | −2 | Elastic limit by galvanometer. |
| 8,000 | 40,000 | .0025 | .00125 | 58 | −1 | Limit of proportionality. |
| 8,200 | 41,000 | .0026 | .00130 | 57 | 0 | |
| 8,400 | 42,000 | .0028 | .00140 | 57 | 0 | |
| 8,600 | 43,000 | .0030 | .00150 | 56 | 1 | |
| 8,800 | 44,000 | .0042 | .00210 | 56 | 1 | Yield point. |
| 9,000 | 45,000 | .0102 | .00510 | 53 | 4 | |
| 9,200 | 46,000 | .0114 | .00570 | 52 | 5 | |
| 9,400 | 47,000 | .0126 | .00630 | 52 | 5 | |
| 9,600 | 48,000 | .0135 | .00675 | 52 | 5 | |
| 9,800 | 49,000 | .0150 | .00750 | 51 | 6 | |
| 10,000 | 50,000 | .0184 | .00920 | 50 | 7 | |
| 11,000 | 55,000 | .0240 | .01200 | 48 | 9 | |
| 12,000 | 60,000 | .0335 | .01675 | 45 | 12 | |
| 18,300 | 91,500 | ..... | ..... | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.17, 0.33* in.
Diameter of fracture, 0.40 in.
Position of fracture, 1.35 in. from the neck.
Appearance of fracture. dull silky 70 per cent; fine granular 30 per cent.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 40,000 lb. per sq. in |
| Elastic limit by galvanometer | 35,000 lb. per sq. in. |
| Yield point | 44,000 lb. per sq. in. |
| Tensile strength | 91,500 lb. per sq. in. |
| Elongation in 2 in. | 25.0 per cent. |
| Contraction of area | 37.2 per cent. |

## TEST 14865.

### NICKEL STEEL NO. 2 NAVY. ARSENAL STEEL.

Marks, 86F.
Diameter, 0.505 in.
Sectional area, 0.20 in.
Gauged length, 2 in.
Inspectors' extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .0002 | .00010 | |
| 2,000 | 10,000 | .0006 | .00030 | |
| 3,000 | 15,000 | .0010 | .00050 | |
| 4,000 | 20,000 | .0014 | .00070 | |
| 5,000 | 25,000 | .0018 | .00090 | |
| 6,000 | 30,000 | .0021 | .00105 | |
| 7,000 | 35,000 | .0025 | .00125 | |
| 8,000 | 40,000 | .0028 | .00140 | |
| ..... | 43,000 | ..... | ..... | Limit of proportionality. |
| 9,000 | 45,000 | .0032 | .00160 | |
| 10,000 | 50,000 | .0038 | .00190 | |
| ..... | 51,000 | ..... | ..... | Yield point. |
| 10,400 | 52,000 | .0068 | .00340 | |
| 10,800 | 54,000 | .0158 | .00790 | |
| 11,200 | 56,000 | .0192 | .00960 | |
| 11,600 | 58,000 | .0235 | .01175 | |
| 19,100 | 95,500 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.12, 0.38* in.
Diameter at fracture, 0.34 in.
Position of fracture, 0.90 in. from the neck.
Appearance of fracture, silky.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 43,000 lb. per sq. in. |
| Yield point | 51,000 lb. per sq. in. |
| Tensile strength | 95,500 lb. per sq. in. |
| Elongation in 2 in. | 25 per cent. |
| Contraction of area | 54.6 per cent. |

## TEST 14892.

### NICKEL STEEL NO. 2. ARSENAL STEEL.

Marks, 204–F.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00027 | .00013 | |
| 2,000 | 10,000 | .00062 | .00031 | |
| 3,000 | 15,000 | .00098 | .00049 | |
| 4,000 | 20,000 | .00133 | .00066 | |
| 5,000 | 25,000 | .00171 | .00086 | |
| 6,000 | 30,000 | .00205 | .00103 | |
| 7,000 | 35,000 | .00239 | .00120 | |
| 7,200 | 36,000 | .00251 | .00126 | |
| 7,400 | 37,000 | .00260 | .00130 | |
| 7,600 | 38,000 | .00261 | .00130 | |
| 7,800 | 39,000 | .00268 | .00134 | |
| 8,000 | 40,000 | .00281 | .00140 | |
| 8,200 | 41,000 | .00287 | .00144 | |
| 8,400 | 42,000 | .00289 | .00145 | |
| 8,600 | 43,000 | .00299 | .00150 | |
| 8,800 | 44,000 | .00305 | .00153 | |
| 9,000 | 45.000 | .00313 | .00157 | |
| 9,200 | 46,000 | .00317 | .00159 | |
| 9,400 | 47,000 | .00327 | .00163 | |
| 9,600 | 48,000 | .00332 | .00166 | |
| 9,800 | 49,000 | .00339 | .00170 | |
| 10,000 | 50,000 | .00348 | .00174 | |
| 10,200 | 51,000 | .00355 | .00177 | |
| 10,400 | 52,000 | .00362 | .00181 | |
| 10,600 | 53,000 | .00372 | .00186 | |
| 10,800 | 54,000 | .00375 | .00188 | |
| 11,000 | 55,000 | .00389 | .00194 | |
| 11,200 | 56,000 | .00390 | .00195 | |
| 11,400 | 57,000 | .00394 | .00197 | |
| 11,600 | 58,000 | .00405 | .00202 | Limit of proportionality. |
| 11,800 | 59,000 | .00414 | .00207 | |
| 12,000 | 60,000 | .00429 | .00214 | |
| 12,200 | 61,000 | .00430 | .00215 | |
| 12,400 | 62,000 | .00447 | .00224 | |
| 12,680 | 63,000 | .00455 | .00228 | |
| 12,800 | 64,000 | .00464 | .00232 | |
| 12,900 | 64,500 | .00759 | .00380 | Yield point. |
| 12,000 | 60,000 | .00799 | .00399 | |
| 12,200 | 61,000 | .00880 | .00440 | |
| 11,474 | 57,370 | .01925 | .00963 | |
| 200 | 1,000 | .01478 | .00739 | Set. |

Extensometer reset to zero.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00027 | .00014 | |
| 2,000 | 10,000 | .00061 | .00030 | |
| 3,000 | 15,000 | .00094 | .00047 | |
| 4,000 | 20,000 | .00135 | .00067 | |
| 5,000 | 25,000 | .00177 | .00089 | |
| 6,000 | 30,000 | .00210 | .00105 | Limit of proportionality. |
| 7,000 | 35,000 | .00250 | .00125 | |
| 7,200 | 36,000 | .00264 | .00132 | |
| 7,400 | 37,000 | .00271 | .00136 | |
| 7,600 | 38,000 | .00273 | .00137 | |
| 7,800 | 39,000 | .00282 | .00141 | |
| 8,000 | 40,000 | .00290 | .00145 | |
| 8,200 | 41,000 | .00302 | .00151 | |
| 8,400 | 42,000 | .00307 | .00154 | |
| 8,600 | 43,000 | .00316 | .00158 | |
| 8,800 | 44,000 | .00326 | .00163 | |
| 9,000 | 45,000 | .00331 | .00165 | |
| 9,200 | 46,000 | .00341 | .00171 | |
| 9,400 | 47,000 | .00347 | .00174 | |
| 9,600 | 48,000 | .00356 | .00178 | |
| 9,800 | 49,000 | .00364 | .00182 | |
| 10,000 | 50,000 | .00375 | .00188 | |
| 10,200 | 51,000 | .00385 | .00193 | |
| 10,400 | 52,000 | .00392 | .00196 | |
| 10,600 | 53,000 | .00402 | .00201 | |
| 10,800 | 54,000 | .00412 | .00206 | |
| 11,000 | 55,000 | .00421 | .00211 | |
| 11,200 | 56,000 | .00434 | .00217 | |
| 11,400 | 57,000 | .00446 | .00223 | |
| 11,600 | 58,000 | .00462 | .00231 | |
| 11,800 | 59,000 | .00515 | .00258 | |
| 12,000 | 60,000 | .00665 | .00332 | Yield point. |
| 12,200 | 61,000 | .01520 | .00760 | |
| 19,300 | 96,500 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.17, 0.35* in.
Diameter at fracture, 0.37 in.
Position of fracture, 1.10 in. from the neck.
Appearance of fracture, fine, silky.

*Summary.*

| | |
|---|---|
| Limit of proportionality | 58,000 lb. per sq. in. |
| Yield point | 64,500 lb. per sq. in. |
| Tensile strength | 96,500 lb. per sq. in. |
| Modulus of elasticity | 28,000,000 lb. per sq. in. |
| Elongation in 2 in | 26.0 per cent. |
| Contraction of area | 46.2 per cent. |
| After stressing to 64,500 lb. per sq. in.: | |
| Limit of proportionality | 30,000 lb. per sq. in. |
| Yield point | 60,000 lb. per sq. in. |
| Modulus of elasticity | 26,700,000 lb. per sq. in. |

## TEST 14893.

### NICKEL STEEL NO. 2. ARSENAL STEEL.

Marks, 206–F.
Diameter, 0.505 in.
Sectional area, 0.20 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00026 | .00013 | |
| 2,000 | 10,000 | .00061 | .00031 | |
| 3,000 | 15,000 | .00097 | .00049 | |
| 4,000 | 20,000 | .00131 | .00066 | |
| 5,000 | 25,000 | .00167 | .00084 | |
| 6,000 | 30,000 | .00203 | .00101 | |
| 7,000 | 35,000 | .00239 | .00120 | |
| 7,200 | 36,000 | .00248 | .00124 | |
| 7,400 | 37,000 | .00253 | .00126 | |
| 7,600 | 38,000 | .00261 | .00130 | |
| 7,800 | 39,000 | .00267 | .00133 | |
| 8,000 | 40,000 | .00276 | .00138 | |
| 8,200 | 41,000 | .00284 | .00142 | |
| 8,400 | 42,000 | .00290 | .00145 | |
| 8,600 | 43,000 | .00297 | .00149 | |
| 8,800 | 44,000 | .00306 | .00153 | |
| 9,000 | 45,000 | .00313 | .00157 | |
| 9,200 | 46,000 | .00321 | .00160 | |
| 9,400 | 47,000 | .00326 | .00163 | |
| 9,600 | 48,000 | .00332 | .00166 | |
| 9,800 | 49,000 | .00341 | .00170 | |
| 10,000 | 50,000 | .00347 | .00174 | |
| 10,200 | 51,000 | .00355 | .00178 | |
| 10,400 | 52,000 | .00362 | .00181 | |
| 10,600 | 53,000 | .00372 | .00186 | |
| 10,800 | 54,000 | .00377 | .00189 | |
| 11,000 | 55,000 | .00388 | .00194 | |
| 11,200 | 56,000 | .00394 | .00197 | Limit of proportionality. |
| 11,400 | 57,000 | .00401 | .00201 | |
| 11,600 | 58,000 | .00410 | .00205 | |
| 11,800 | 59,000 | .00426 | .00213 | |
| 12,000 | 60,000 | ..... | ..... | Yield point. |
| 11.076 | 55,380 | .00835 | .00417 | |
| 200 | 1,000 | .01536 | .00768 | Set. |

Extensometer reset to zero.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 200 | 1,000 | 0. | 0. | |
| 1,000 | 5,000 | .00028 | .00014 | |
| 2,000 | 10,000 | .00062 | .00031 | |
| 3,000 | 15,000 | .00097 | .00049 | |
| 3,600 | 18,000 | ..... | ..... | Limit of proportionality. |
| 4,000 | 20,000 | .00135 | .00068 | |
| 5,000 | 25,000 | .00174 | .00087 | |
| 6,000 | 30,000 | .00213 | .00107 | |
| 7,000 | 35,000 | .00251 | .00125 | |
| 7,200 | 36,000 | .00262 | .00131 | |
| 7,400 | 37,000 | .00267 | .00134 | |
| 7,600 | 38,000 | .00277 | .00138 | |
| 7,800 | 39,000 | .00284 | .00142 | |
| 8,000 | 40,000 | .00292 | .00146 | |
| 8,200 | 41,000 | .00302 | .00151 | |
| 8,400 | 42,000 | .00309 | .00155 | |
| 8,600 | 43,000 | .00316 | .00158 | |
| 8,800 | 44,000 | .00326 | .00163 | |
| 9,000 | 45,000 | .00331 | .00166 | |
| 9,200 | 46,000 | .00346 | .00173 | |
| 9,400 | 47,000 | .00350 | .00175 | |
| 9,600 | 48,000 | .00359 | .00179 | |
| 9,800 | 49,000 | .00367 | .00184 | |
| 10,000 | 50,000 | .00379 | .00189 | |
| 10,200 | 51,000 | .00389 | .00195 | |
| 10,400 | 52,000 | .00399 | .00199 | |
| 10,600 | 53,000 | .00410 | .00205 | |
| 10,800 | 54,000 | .00426 | .00213 | |
| 11,000 | 55,000 | .00450 | .00225 | |
| 11,200 | 56,000 | ..... | ..... | Yield point. |
| 10,506 | 52,530 | .00570 | .00285 | |
| 18,000 | 90,000 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.38*, 0.20 in.
Diameter at fracture, 0.33 in.
Position of fracture, 1.35 in. from the neck.
Appearance of fracture, fine silky, cup shaped.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 56,000 lb. per sq. in. |
| Yield point | 60,000 lb. per sq. in. |
| Tensile strength | 90,000 lb. per sq. in. |
| Modulus of elasticity | 28,200,000 lb. per sq. in. |
| Elongation in 2 in | 29.0 per cent. |
| Contraction of area | 57.2 per cent. |
| After stressing to 60,000 lb. per sq. in.: | |
| Limit of proportionality | 18,000 lb. per sq. in. |
| Yield point | 56,000 lb. per sq. in. |
| Modulus of elasticity | 28,000,000 lb. per sq. in. |

## TEST 14903.

### BRONZE No. 3. ARSENAL BRONZE.

Marks, 4324.
Diameter, 0.798 in.
Sectional area, 0.50 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 1,000 | 2,000 | 0. | 0. | |
| 2,000 | 4,000 | .00031 | .00015 | |
| 3,000 | 6,000 | .00060 | .00030 | |
| 4,000 | 8,000 | .00091 | .00045 | |
| 5,000 | 10,000 | .00121 | .00061 | Limit of proportionality. |
| 6,000 | 12,000 | .00155 | .00077 | |
| 7,000 | 14,000 | .00186 | .00093 | |
| 8,000 | 16,000 | .00227 | .00113 | |
| 9,000 | 18,000 | .00279 | .00140 | |
| 10,000 | 20,000 | .00331 | .00166 | |
| 11,000 | 22,000 | .00414 | .00207 | |
| 12,000 | 24,000 | .00497 | .00248 | |
| 13,000 | 26,000 | .00626 | .00313 | |
| 14,000 | 28,000 | .00823 | .00411 | |
| 15,000 | 30,000 | .01096 | .00548 | |
| 16,000 | 32,000 | .01528 | .00764 | |
| 1,000 | 2,000 | .01138 | .00569 | Set. |

Extensometer reset to zero.

| | | | | |
|---|---|---|---|---|
| 1,000 | 2,000 | 0. | 0. | |
| 2,000 | 4,000 | .00033 | .00017 | |
| 3,000 | 6,000 | .00064 | .00032 | |
| 4,000 | 8,000 | .00095 | .00047 | |
| 5,000 | 10,000 | .00128 | .00064 | |
| 6,000 | 12,000 | .00164 | .00082 | |
| 7,000 | 14,000 | .00198 | .00099 | |
| 8,000 | 16,000 | .00232 | .00116 | |
| 9,000 | 18,000 | .00269 | .00135 | |
| 10,000 | 20,000 | .00309 | .00155 | |
| 11,000 | 22,000 | .00346 | .00173 | |
| 12,000 | 24,000 | .00389 | .00195 | |
| 13,000 | 26,000 | .00430 | .00215 | |
| 14,000 | 28,000 | .00476 | .00238 | |
| 15,000 | 30,000 | .00526 | .00263 | |
| 16,000 | 32,000 | .00592 | .00296 | |
| 17,000 | 34,000 | .01158 | .00579 | |
| 34,400 | 68,800 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.26*, 0.20 in.
Diameter at fracture, 0.69 in.
Position of fracture, 1.20 in. from the neck.
Appearance of fracture, light yellow.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 10,000 lb. per sq. in. |
| Tensile strength | 68,800 lb. per sq. in. |
| Modulus of elasticity | 13,400,000 lb. per sq. in. |
| Elongation in 2 in. | 23.0 per cent. |
| Contraction of area | 25.2 per cent. |
| After a set of 0.00569 in. per in. elongation: | |
| Limit of proportionality | 10,000 lb. per sq. in. |
| Modulus of elasticity | 12,600,000 lb. per sq. in. |

## TEST 14867.

### BRONZE NO. 4. ARSENAL BRONZE.

Marks, 4218.
Diameter, 0.798 in.
Sectional area, 0.50 sq. in.
Gauged length, 2 in.
Inspectors' extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 500 | 1,000 | 0. | 0. | |
| 2,500 | 5,000 | .0006 | .00030 | |
| 5,000 | 10,000 | .0014 | .00070 | Limit of proportionality. |
| 7,500 | 15,000 | .0025 | .00125 | |
| 10,000 | 20,000 | .0042 | .00210 | |
| 12,500 | 25,000 | .0075 | .00375 | |
| 15,000 | 30,000 | .0159 | .00795 | |
| 15,500 | 31,000 | .0185 | .00925 | |
| 16,000 | 32,000 | .0217 | .01085 | |
| 16,500 | 33,000 | .0256 | .01280 | |
| 17,000 | 34,000 | .0300 | .01500 | |
| 17,500 | 35,000 | .0348 | .01740 | |
| 18,000 | 36,000 | .0385 | .01925 | |
| 18,500 | 37,000 | .0453 | .02265 | |
| 19,000 | 38,000 | .0515 | .02575 | |
| 19,500 | 39,000 | .0570 | .02850 | |
| 20,000 | 40,000 | .0658 | .03290 | |
| 20,500 | 41,000 | .0694 | .03470 | |
| 21,000 | 42,000 | .0840 | .04200 | |
| 32,900 | 65,800 | ..... | ..... | Tensile strength. |

Elongation of inch sections: 0.42, 0.43 in.
Diameter at fracture, 0.62 in.
Position of fracture, 1.40 in. from the neck.
Appearance of fracture, light yellow

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 10,000 lb. per sq. in. |
| Tensile strength | 65,800 lb. per sq. in. |
| Elongation in 2 in | 42 5 per cent. |
| Contraction of area | 39. 6 per cent. |

## TEST 14901.

### BRONZE NO. 4. ARSENAL BRONZE.

Marks, 4308.
Diameter, 0.798 in.
Sectional area, 0.50 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 1,000 | 2,000 | 0. | 0. | |
| 2,000 | 4,000 | .00025 | .00013 | |
| 3,000 | 6,000 | .00053 | .00027 | Limit of proportionality. |
| 4,000 | 8,000 | .00085 | .00042 | |
| 5,000 | 10,000 | .00115 | .00058 | |
| 6,000 | 12,000 | .00152 | .00076 | |
| 7,000 | 14,000 | .00197 | .00098 | |
| 8,000 | 16,000 | .00247 | .00124 | |
| 9,000 | 18,000 | .00316 | .00158 | |
| 10,000 | 20,000 | .00395 | .00198 | |
| 11,000 | 22,000 | .00485 | .00243 | |
| 12,000 | 24,000 | .00615 | .00307 | |
| 13,000 | 26,000 | .00755 | .00377 | |
| 14,000 | 28,000 | .00982 | .00491 | |
| 15,000 | 30,000 | .01305 | .00653 | |
| 1,000 | 2,000 | .01116 | .00558 | Set. |

Extensometer reset to zero.

| | | | | |
|---|---|---|---|---|
| 1,000 | 2,000 | 0. | 0. | |
| 2,000 | 4,000 | .00030 | .00015 | |
| 3,000 | 6,000 | .00059 | .00030 | |
| 4,000 | 8,000 | .00091 | .00045 | |
| 5,000 | 10,000 | .00123 | .00061 | Limit of proportionality. |
| 6,000 | 12,000 | .00157 | .00079 | |
| 7,000 | 14,000 | .00193 | .00096 | |
| 8,000 | 16,000 | .00227 | .00113 | |
| 9,000 | 18,000 | .00264 | .00132 | |
| 10,000 | 20,000 | .00308 | .00154 | |
| 11,000 | 22,000 | .00340 | .00170 | |
| 12,000 | 24,000 | .00383 | .00191 | |
| 13,000 | 26,000 | .00424 | .00212 | |
| 14,000 | 28,000 | .00473 | .00236 | |
| 15,000 | 30,000 | .00527 | .00263 | |
| 16,000 | 32,000 | .00600 | .00300 | |
| 34,600 | 69,200 | ..... | ..... | Tensile strength. |

Elongation after fracture: 0.76 in. in 2 in. =38 per cent.
Elongation of inch sections: 0.38*, 0.38* in.
Diameter at fracture, 0.64 in.
Contraction of area, 35.7 per cent.
Position of fracture, 1.40 in. from the neck.
Appearance of fracture, light yellow, oblique.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 6,000 lb. per sq.in. |
| Tensile strength | 69,200 lb. per sq.in. |
| Modulus of elasticity | 14,600,000 lb. per sq.in. |
| After a set of 0.00558 in. per in. elongation: | |
| Limit of proportionality | 10,000 lb. per sq.in. |
| Modulus of elasticity | 13,000,000 lb. per sq.in. |

## TEST 14902.

### BRONZE NO. 4. ARSENAL BRONZE.

Marks, 4317.
Diameter, 0.798 in.
Sectional area, 0.50 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongation. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 1,000 | 2,000 | 0. | 0. | |
| 2,000 | 4,000 | .00026 | .00013 | |
| 3,000 | 6,000 | .00057 | .00029 | |
| 4,000 | 8,000 | .00085 | .00042 | Limit of proportionality. |
| 5,000 | 10,000 | .00118 | .00059 | |
| 6,000 | 12,000 | .00151 | .00076 | |
| 7,000 | 14,000 | .00197 | .00098 | |
| 8,000 | 16,000 | .00260 | .00130 | |
| 9,000 | 18,000 | .00351 | .00176 | |
| 10,000 | 20,000 | .00468 | .00234 | |
| 11,000 | 22,000 | .00618 | .00309 | |
| 12,000 | 24,000 | .00829 | .00415 | |
| 13,000 | 26,000 | .01146 | .00573 | |
| 14,000 | 28,000 | .01536 | .00768 | |
| 1,000 | 2,000 | .01032 | .00516 | Set |

Extensometer reset to zero.

| | | | | |
|---|---|---|---|---|
| 1,000 | 2,000 | 0. | 0. | |
| 2,000 | 4,000 | .00029 | .00015 | |
| 3,000 | 6,000 | .00059 | .00030 | |
| 4,000 | 8,000 | .00088 | .00044 | |
| 5,000 | 10,000 | .00123 | .00062 | |
| 6,000 | 12,000 | .00153 | .00076 | |
| 7,000 | 14,000 | .00185 | .00093 | |
| 8,000 | 16,000 | .00224 | .00112 | |
| 9,000 | 18,000 | .00261 | .00130 | |
| 10,000 | 20,000 | .00301 | .00150 | |
| 11,000 | 22,000 | .00342 | .00171 | |
| 12,000 | 24,000 | .00389 | .00194 | |
| 13,000 | 26,000 | .00438 | .00219 | |
| 14,000 | 28,000 | .00506 | .00253 | |
| 15,000 | 30,000 | .01137 | .00569 | |
| 31,900 | 63,800 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.46*, 0.43* in.
Diameter at fracture, 0.61 in.
Position of fracture, 1.6 in. from the neck. Appearance of fracture, light yellow.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 8,000 lb. per sq. in. |
| Tensile strength | 63,800 lb. per sq. in. |
| Modulus of elasticity | 14,000,000 lb. per sq. in. |
| Elongation in 2 in | 44.5 per cent. |
| Contraction of area | 41.6 per cent. |
| After a set of 0.00516 in. per in. elongation: | |
| Limit of proportionality | 8000 lb. per sq. in. |
| Modulus of elasticity | 13,700,000 lb. per sq. in. |

## TEST 14904.

### BRONZE NO. 4. ARSENAL BRONZE.

Marks, 4354.
Diameter, 0.798 in.
Sectional area, 0.50 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongation. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 1,000 | 2,000 | 0. | 0. | |
| 2,000 | 4,000 | .00031 | .00015 | |
| 3,000 | 6,000 | .00053 | .00027 | Limit of proportionality. |
| 4,000 | 8,000 | .00085 | .00042 | |
| 5,000 | 10,000 | .00119 | .00059 | |
| 6,000 | 12,000 | .00161 | .00081 | |
| 7,000 | 14,000 | .00212 | .00106 | |
| 8,000 | 16,000 | .00277 | .00139 | |
| 9,000 | 18,000 | .00369 | .00185 | |
| 10,000 | 20,000 | .00469 | .00234 | |
| 11,000 | 22,000 | .00579 | .00289 | |
| 12,000 | 24,000 | .00726 | .00363 | |
| 13,000 | 26,000 | .00947 | .00474 | |
| 14,000 | 28,000 | .01290 | .00645 | |
| 1,000 | 2,000 | .00789 | .00394 | Set. |
| 33,300 | 66,600 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.39, 0.43* in.
Diameter at fracture, 0.63 in.
Position of fracture, at middle of stem.
Appearance of fracture, light yellow, oblique.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 6,000 lb. per sq. in. |
| Tensile strength | 66,600 lb. per sq. in. |
| Modulus of elasticity | 15,000,000 lb. per sq. in. |
| Elongation in 2 in | 41.0 per cent. |
| Contraction of area | 37.7 per cent. |

## TEST 14905.

### BRONZE NO. 4. ARSENAL BRONZE.

Marks, 4357.
Diameter, 0.798 in.
Sectional area, 0.50 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 1,000 | 2,000 | 0. | 0. | |
| 2,000 | 4,000 | .00030 | .00015 | |
| 3,000 | 6,000 | .00056 | .00028 | |
| 4,000 | 8,000 | .00083 | .00042 | |
| 5,000 | 10,000 | .00115 | .00057 | Limit of proportionality. |
| 6,000 | 12,000 | .00150 | .00075 | |
| 7,000 | 14,000 | .00192 | .00096 | |
| 8,000 | 16,000 | .00249 | .00125 | |
| 9,000 | 18,000 | .00340 | .00170 | |
| 10,000 | 20,000 | .00452 | .00226 | |
| 11,000 | 22,000 | .00598 | .00299 | |
| 12,000 | 24,000 | .00775 | .00388 | |
| 13,000 | 26,000 | .01040 | .00520 | |
| 14,000 | 28,000 | .01423 | .00712 | |
| | | .01443 | .00722 | |
| 1,000 | 2,000 | .00944 | .00472 | Set. |
| 32,100 | 64,200 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.42, 0.48* in.
Diameter at fracture, 0.61 in.
Position of fracture, 1.30 in. from the neck.
Appearance of fracture, light yellow, oblique.

SUMMARY.

| | |
|---|---|
| Limit of proportionality | 10,000 lb. per sq. in. |
| Tensile strength | 64,200 lb. per sq. in. |
| Modulus of elasticity | 14,000,000 lb. per sq. in. |
| Elongation in 2 in. | 45.0 per cent. |
| Contraction of area | 41.6 per cent. |

# COLUMN PROGRAMME.

## COMPRESSIVE TESTS OF STEEL-BUILT I COLUMNS.

[illegible]

BRONZE NO. 4. ARSENAL BRONZE.

Marks, 4357.
Diameter, 0.798 in.
Sectional area, 0.50 sq. in.
Gauged length, 2 in.
Ewing extensometer used on 2-in. length.

| Applied loads | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total | Per square inch. | In 2 inches | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 1,000 | 2,000 | 0. | 0. | |
| 2,000 | 4,000 | .00060 | .00015 | |
| 3,000 | 6,000 | .00056 | .00028 | |
| 4,000 | 8,000 | .00083 | .00042 | |
| 5,000 | 10,000 | .00115 | .00057 | Limit of proportionality. |
| 6,000 | 12,000 | .00150 | .00075 | |
| 7,000 | 14,000 | .00192 | .00096 | |
| 8,000 | 16,000 | .00249 | .00125 | |
| 9,000 | 18,000 | .00340 | .00170 | |
| 10,000 | 20,000 | .00452 | .00226 | |
| 11,000 | 22,000 | .00598 | .00299 | |
| 12,000 | 24,000 | .00775 | .00388 | |
| 13,000 | 26,000 | .01040 | .00520 | |
| 14,000 | 28,000 | .01439 | .00712 | |
| [illegible] | [illegible] | .01443 | .00722 | |
| [illegible] | [illegible] | .00944 | .00472 | Set |
| [illegible] | [illegible] | | | Tensile strength. |

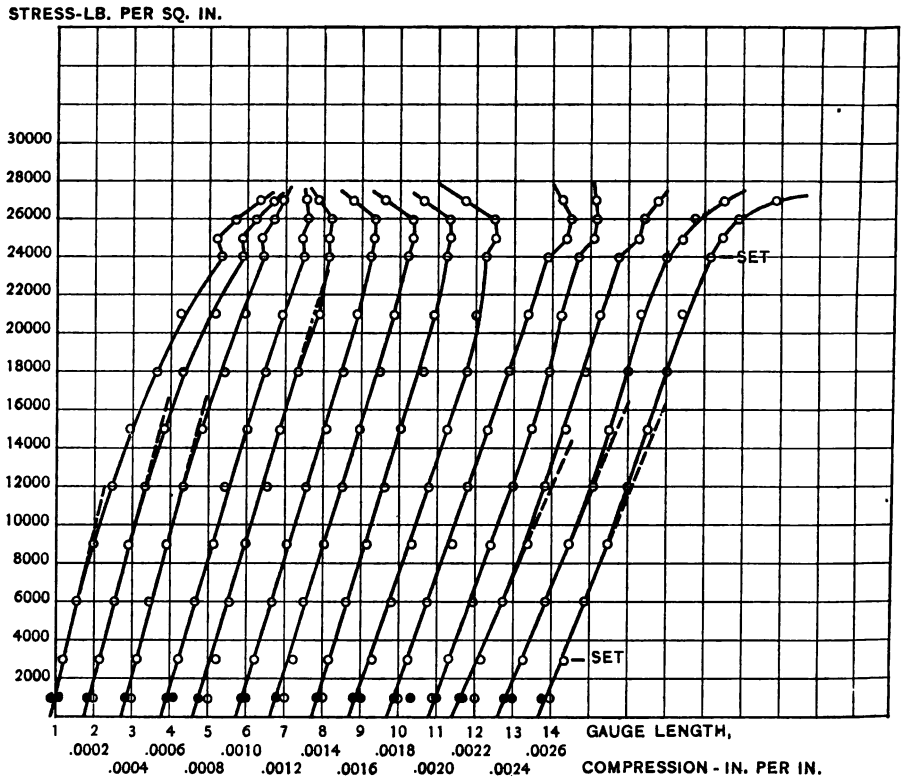
Elongation of inch sections, 0.42, 0.48* in.
Diameter at fracture, 0.61 in.
Location of fracture, 1.50 in. from the neck.
Appearance of fracture, light yellow, oblique.

[illegible]

[illegible] 70,000 lb. per sq. in.
[illegible] 44,200 lb. per sq. in.
[illegible] 84,300 lb. per sq. in.
[illegible] 1 per cent.
[illegible] 3 per cent.

# COLUMN PROGRAMME

## COMPRESSIVE TESTS OF STEEL-BUILT I [illegible]

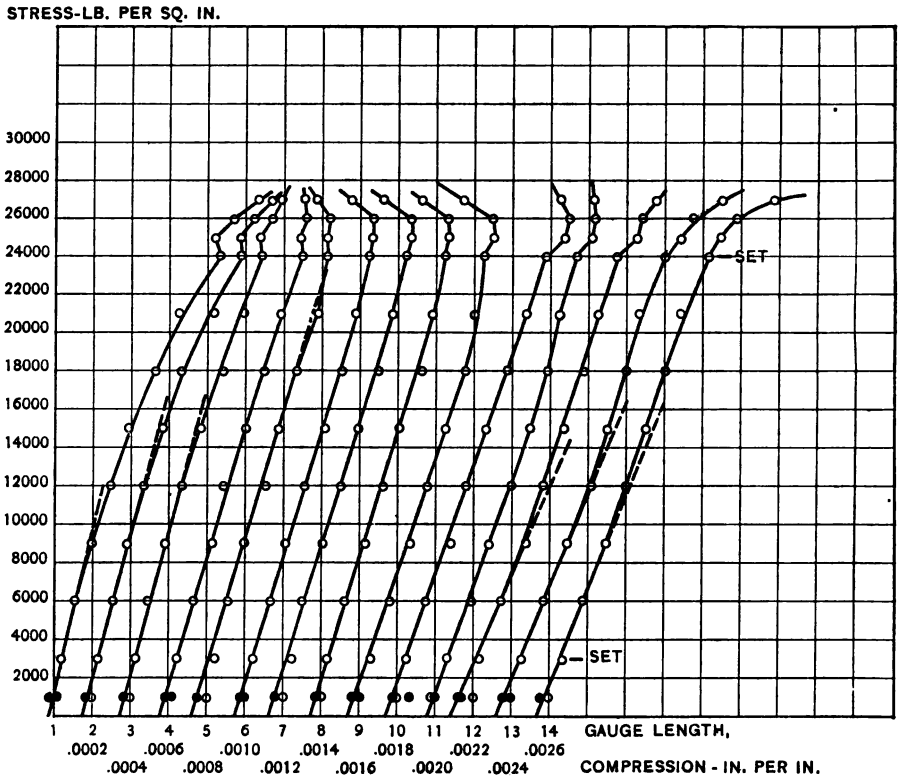



TEST NO. 14910.

COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE A.

| | 11 | 12 | | 13 | | 14 | | Deflections. | |
|---|---|---|---|---|---|---|---|---|---|
| | Compression per inch. | Compressometer reading. | Compression per inch. | Compressometer reading. | Compression per inch. | Compressometer reading. | Compression per inch. | Horizontal. | Vertical. |
| | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* |
| 6 | 0. | 0.0041 | 0. | 0.0078 | 0. | 0.0063 | 0. | ..... | ..... |
| 6 | 0. | .0063 | 0. | .0093 | 0. | .0080 | 0. | ..... | ..... |
| 2 | 0. | .0084 | 0. | .0086 | 0. | .0124 | 0. | ..... | ..... |
| 4 | 0. | .0052 | 0. | .0027 | 0. | .0070 | 0. | 0. | 0. |
| 3 | .00007 | .0045 | .00004 | .0084 | .00006 | .0071 | .00008 | ..... | ..... |
| 2 | .00006 | .0071 | .00008 | .0099 | .00006 | .0087 | .00007 | ..... | ..... |
| 7 | .00005 | .0089 | .00005 | .0092 | .00006 | .0130 | .00006 | ..... | ..... |
| 0 | .00006 | .0058 | .00006 | .0033 | .00006 | .0074 | .00004 | 0. | 0. |
| 5 | −.00001 | .0036 | −.00005 | .0075 | −.00003 | .0060 | −.00003 | ..... | ..... |
| 4 | −.00002 | .0063 | 0. | .0089 | −.00004 | .0078 | −.00002 | ..... | ..... |
| 0 | −.00002 | .0062 | −.00002 | .0084 | −.00002 | .0122 | −.00002 | ..... | ..... |
| 3 | −.00001 | .0051 | −.00001 | .0026 | −.00001 | .0068 | −.00002 | 0. | 0. |
| 5 | .00019 | .0056 | .00015 | .0096 | .00018 | .0081 | .00018 | ..... | ..... |
| 2 | .00016 | .0081 | .00018 | .0108 | .00015 | .0097 | .00017 | ..... | ..... |
| 6 | .00014 | .0098 | .00014 | .0100 | .00014 | .0138 | .00014 | ..... | ..... |
| 8 | .00014 | .0067 | .00015 | .0042 | .00015 | .0083 | .00013 | 0.01 | 0. |
| 5 | .00029 | .0069 | .00028 | .0108 | .00030 | .0093 | .00030 | ..... | ..... |
| 3 | .00027 | .0092 | .00029 | .0120 | .00027 | .0108 | .00028 | ..... | ..... |
| 6 | .00024 | .0108 | .00024 | .0110 | .00024 | .0148 | .00024 | ..... | ..... |
| 0 | .00026 | .0077 | .00025 | .0052 | .00025 | .0095 | .00025 | 0.02 | 0.01 |
| 5 | .00039 | .0078 | .00037 | .0120 | .00042 | .0103 | .00040 | ..... | ..... |
| 4 | .00038 | .0103 | .00040 | .0130 | .00037 | .0119 | .00039 | ..... | ..... |
| 7 | .00035 | 0118 | .00034 | .0121 | .00035 | .0159 | .00035 | ..... | ..... |
| 0 | .00036 | .0087 | .00035 | .0062 | .00035 | .0106 | .00036 | 0.02 | 0.01 |
| 6 | .00050 | .0089 | .00048 | .0129 | .00051 | .0114 | .00051 | ..... | ..... |
| 4 | .00048 | .0113 | .00050 | .0140 | .00047 | .0130 | .00050 | ..... | ..... |
| 8 | .00048 | .0129 | .00045 | .0132 | .00046 | .0170 | .00046 | ..... | ..... |
| 2 | .00048 | .0099 | .00047 | .0074 | .00047 | .0119 | .00049 | 0.03 | 0.02 |
| 5 | .00059 | .0099 | .00058 | .0138 | .00060 | .0124 | .00061 | ..... | ..... |
| 8 | .00062 | .0128 | .00065 | .0153 | .00060 | .0142 | .00062 | ..... | ..... |
| 3 | .00061 | .0142 | .00056 | .0146 | .00060 | .0183 | .00059 | ..... | ..... |
| 3 | .00059 | .0110 | .00058 | .0086 | .00059 | .0134 | .00064 | 0.04 | 0.02 |
| 1 | .00065 | .0107 | .00066 | .0146 | .00068 | .0132 | .00069 | ..... | ..... |
| 2 | .00076 | .0140 | .00077 | .0166 | .00073 | .0156 | .00076 | ..... | ..... |
| 8 | .00076 | .0156 | .00072 | .0161 | .00075 | .0194 | .00070 | ..... | ..... |
| 3 | .00069 | .0123 | .00071 | .0101 | .00074 | .0149 | .00079 | 0.07 | 0.02 |
| 0 | .00074 | .0117 | .00076 | .0158 | .00080 | .0146 | .00083 | ..... | ..... |
| 1 | .00095 | .0159 | .00096 | .0181 | .00088 | .0168 | .00088 | ..... | ..... |
| 7 | .00095 | .0172 | .00088 | .0176 | .00090 | .0206 | .00082 | ..... | ..... |
| 2 | .00078 | .0133 | .00081 | .0118 | .00091 | .0167 | .00097 | 0.13 | 0.02 |
| 5 | −.00001 | .0035 | −.00006 | .0077 | −.00001 | .0061 | −.00002 | ..... | ..... |
| 3 | .00007 | .0074 | .00011 | .0099 | .00006 | .0088 | .00008 | ..... | ..... |
| 3 | .00011 | .0093 | .00009 | .0098 | .00012 | .0131 | .00007 | ..... | ..... |
| 0 | .00006 | .0058 | .00006 | .0039 | .00012 | .0080 | .00010 | 0.02 | 0.02 |
| 8 | .00082 | .0127 | .00086 | .0167 | .00089 | .0153 | .00090 | ..... | ..... |
| 6 | .00090 | .0155 | .00092 | .0177 | .00084 | .0166 | .00086 | ..... | ..... |
| 5 | .00093 | .0169 | .00085 | .0172 | .00086 | .0203 | .00079 | ..... | ..... |
| 2 | .00088 | .0141 | .00089 | .0133 | .00106 | .0177 | .00107 | 0.11 | 0.02 |
| 0 | .00084 | .0130 | .00089 | .0174 | .00096 | .0162 | .00099 | ..... | ..... |
| 4 | .00098 | .0163 | .00100 | .0181 | .00088 | .0168 | .00088 | ..... | ..... |
| 5 | .00103 | .0176 | .00092 | .0178 | .00092 | .0206 | .00082 | ..... | ..... |
| 5 | .00091 | .0146 | .00094 | .0142 | .00115 | .0188 | .00118 | 0.16 | 0.02 |
| 9 | .00083 | .0137 | .00096 | .0189 | .00111 | .0181 | .00118 | ..... | ..... |
| 8 | .00112 | .0169 | .00106 | .0177 | .00084 | .0157 | .00077 | ..... | ..... |
| 3 | .00121 | .0184 | .00100 | .0177 | .00091 | .0193 | .00069 | ..... | ..... |
| 0 | .00086 | .0151 | .00099 | .0163 | .00136 | .0221 | .00151 | 0.37 | 0.00 |

o the east at middle of length.

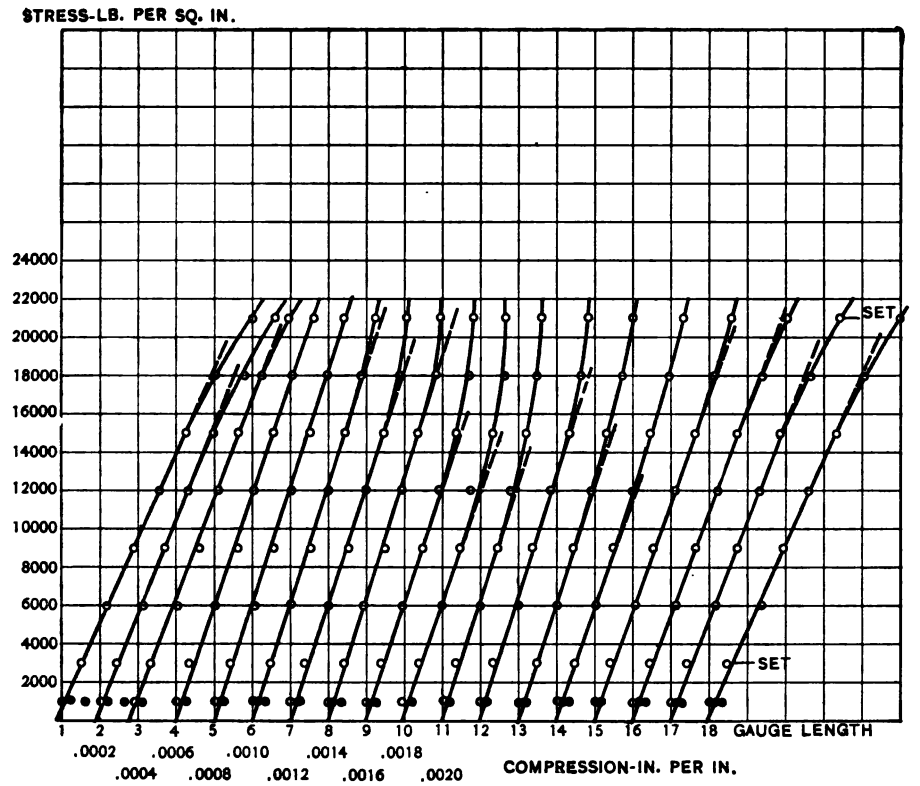



TEST NO. 14910.

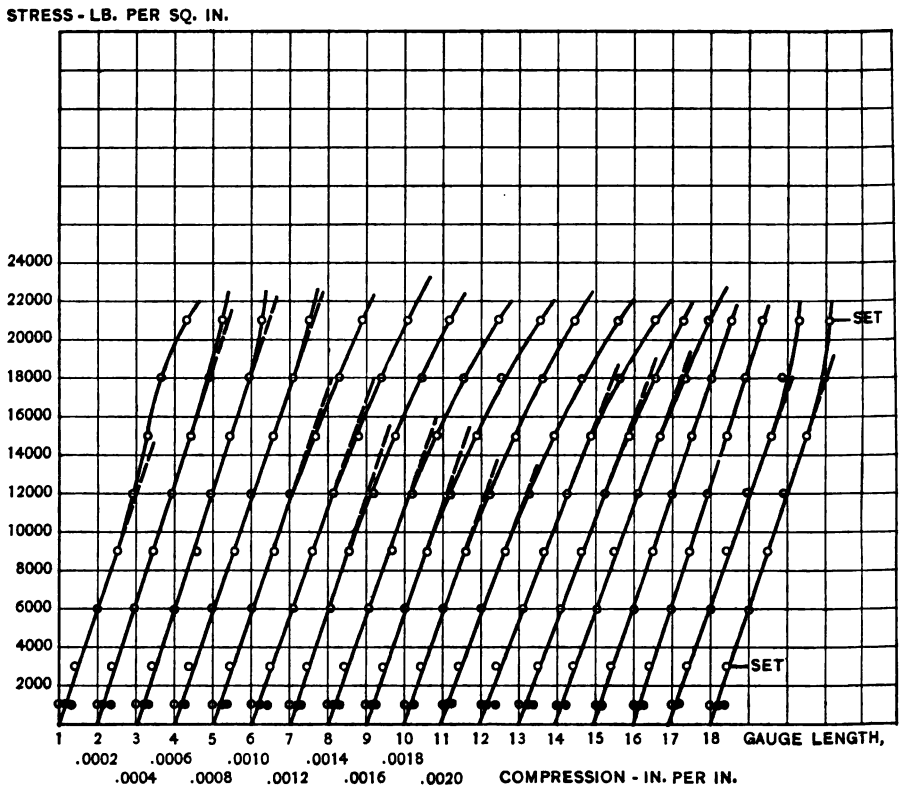
COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE A.

| | 11 | | 12 | | 13 | | 14 | | Deflections. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Compression per inch. | Compressometer reading. | Compression per inch. | Compressometer reading. | Compression per inch. | Compressometer reading. | Compression per inch. | Horizontal. | Vertical. |
| | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* |
| 6 | 0. | 0.0041 | 0. | 0.0078 | 0. | 0.0063 | 0. | | |
| 6 | 0. | .0063 | 0. | .0093 | 0. | .0080 | 0. | | |
| 2 | 0. | .0084 | 0. | .0086 | 0. | .0124 | 0. | | |
| 4 | 0. | .0052 | 0. | .0027 | 0. | .0070 | 0. | 0. | 0. |
| 3 | .00007 | .0045 | .00004 | .0084 | .00006 | .0071 | .00008 | | |
| 2 | .00006 | .0071 | .00008 | .0099 | .00006 | .0087 | .00007 | | |
| 7 | .00005 | .0089 | .00005 | .0092 | .00006 | .0130 | .00006 | | |
| 0 | .00006 | .0058 | .00006 | .0033 | .00006 | .0074 | .00004 | 0. | 0. |
| 5 | −.00001 | .0036 | −.00005 | .0075 | −.00003 | .0060 | −.00003 | | |
| 4 | −.00002 | .0063 | 0. | .0089 | −.00004 | .0078 | −.00002 | | |
| 0 | −.00002 | .0082 | −.00002 | .0084 | −.00002 | .0122 | −.00002 | | |
| 3 | −.00001 | .0051 | −.00001 | .0026 | −.00001 | .0068 | −.00002 | 0. | 0. |
| 5 | .00019 | .0056 | .00015 | .0096 | .00018 | .0081 | .00018 | | |
| 2 | .00016 | .0081 | .00018 | .0108 | .00015 | .0097 | .00017 | | |
| 6 | .00014 | .0098 | .00014 | .0100 | .00014 | .0138 | .00014 | | |
| 8 | .00014 | .0067 | .00015 | .0042 | .00015 | .0083 | .00013 | 0.01 | 0. |
| 5 | .00029 | .0069 | .00028 | .0108 | .00030 | .0093 | .00030 | | |
| 3 | .00027 | .0092 | .00029 | .0120 | .00027 | .0108 | .00028 | | |
| 6 | .00024 | .0108 | .00024 | .0110 | .00024 | .0148 | .00024 | | |
| 0 | .00026 | .0077 | .00025 | .0052 | .00025 | .0095 | .00025 | 0.02 | 0.01 |
| 5 | .00039 | .0078 | .00037 | .0120 | .00042 | .0103 | .00040 | | |
| 4 | .00038 | .0103 | .00040 | .0130 | .00037 | .0119 | .00039 | | |
| 7 | .00035 | 0118 | .00034 | .0121 | .00035 | .3159 | .00035 | | |
| 0 | .00036 | .0087 | .00035 | .0062 | .00035 | .0106 | .00036 | 0.02 | 0.01 |
| 6 | .00050 | .0089 | .00048 | .0129 | .00051 | .0114 | .00051 | | |
| 4 | .00048 | .0113 | .00050 | .0140 | .00047 | .0130 | .00050 | | |
| 8 | .00046 | .0129 | .00045 | .0132 | .00046 | .0170 | .00046 | | |
| 2 | .00048 | .0099 | .00047 | .0074 | .00047 | .0119 | .00049 | 0.03 | 0.02 |
| 5 | .00059 | .0099 | .00058 | .0138 | .00060 | .0124 | .00061 | | |
| 8 | .00062 | .0128 | .00065 | .0153 | .00060 | .0142 | .00062 | | |
| 3 | .00061 | .0142 | .00056 | .0146 | .00060 | .0183 | .00059 | | |
| 3 | .00059 | .0110 | .00058 | .0086 | .00059 | .0134 | .00064 | 0.04 | 0.02 |
| 1 | .00065 | .0107 | .00066 | .0146 | .00068 | .0132 | .00069 | | |
| 2 | .00076 | .0140 | .00077 | .0166 | .00073 | .0156 | .00076 | | |
| 8 | .00076 | .0156 | .00072 | .0161 | .00075 | .0194 | .00070 | | |
| 3 | .00069 | .0123 | .00071 | .0101 | .00074 | .0149 | .00079 | 0.07 | 0.02 |
| 0 | .00074 | .0117 | .00076 | .0158 | .00080 | .0146 | .00083 | | |
| 1 | .00095 | .0159 | .00096 | .0181 | .00088 | .0168 | .00088 | | |
| 7 | .00095 | .0172 | .00088 | .0176 | .00090 | .0206 | .00082 | | |
| 2 | .00078 | .0133 | .00081 | .0118 | .00091 | .0167 | .00097 | 0.13 | 0.02 |
| 5 | −.00001 | .0035 | −.00006 | .0077 | −.00001 | .0061 | −.00002 | | |
| 3 | .00007 | .0074 | .00011 | .0099 | .00006 | .0088 | .00008 | | |
| 3 | .00011 | .0093 | .00009 | .0098 | .00012 | .0131 | .00007 | | |
| 0 | .00006 | .0058 | .00006 | .0039 | .00012 | .0080 | .00010 | 0.02 | 0.02 |
| 8 | .00082 | .0127 | .00086 | .0167 | .00089 | .0153 | .00090 | | |
| 6 | .00090 | .0155 | .00092 | .0177 | .00084 | .0166 | .00086 | | |
| 5 | .00093 | .0169 | .00085 | .0172 | .00086 | .0203 | .00079 | | |
| 2 | .00088 | .0141 | 00089 | .0133 | .00106 | .0177 | .00107 | 0.11 | 0.02 |
| 0 | .00084 | .0130 | .00089 | .0174 | .00096 | .0162 | .00099 | | |
| 4 | .00098 | .0163 | .00100 | .0181 | .00088 | .0168 | .00088 | | |
| 5 | .00103 | .0176 | .00092 | .0178 | .00092 | .0206 | .00082 | | |
| 5 | .00091 | .0146 | .00094 | .0142 | .00115 | .0188 | .00118 | 0.16 | 0.02 |
| 9 | .00083 | .0137 | .00096 | .0189 | .00111 | .0181 | .00118 | | |
| 8 | .00112 | .0169 | .00106 | .0177 | .00084 | .0157 | .00077 | | |
| 3 | .00121 | .0184 | .00100 | .0177 | .00091 | .0193 | .00069 | | |
| 0 | .00086 | .0151 | .00099 | .0163 | .00136 | .0221 | .00151 | 0.37 | 0.00 |

o the east at middle of length.

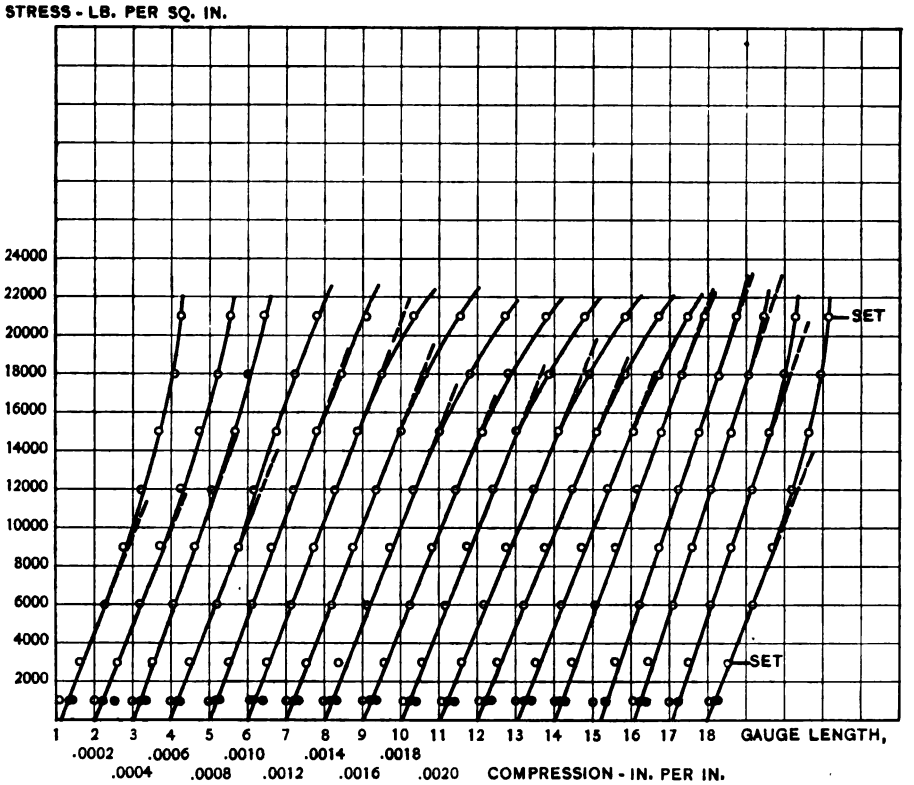



TEST NO. 14911 COMPRESSIVE TEST OF STEEL COLUMN. ANGLE A.



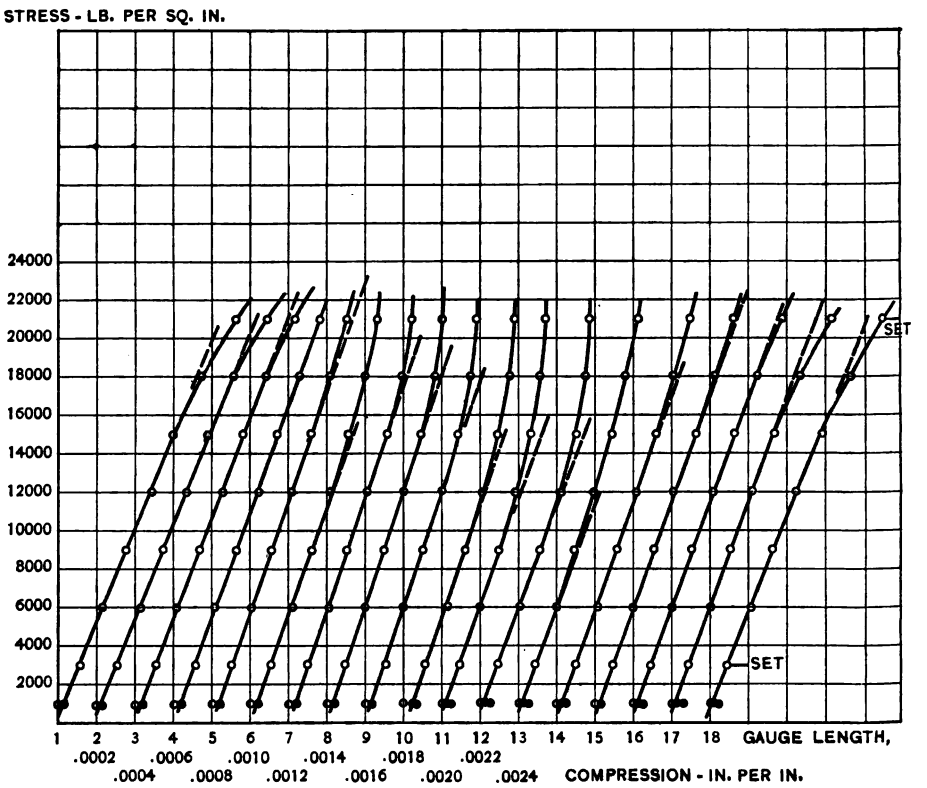

TEST NO. 14911.

COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE B.




TEST NO. 14911.

COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE C.



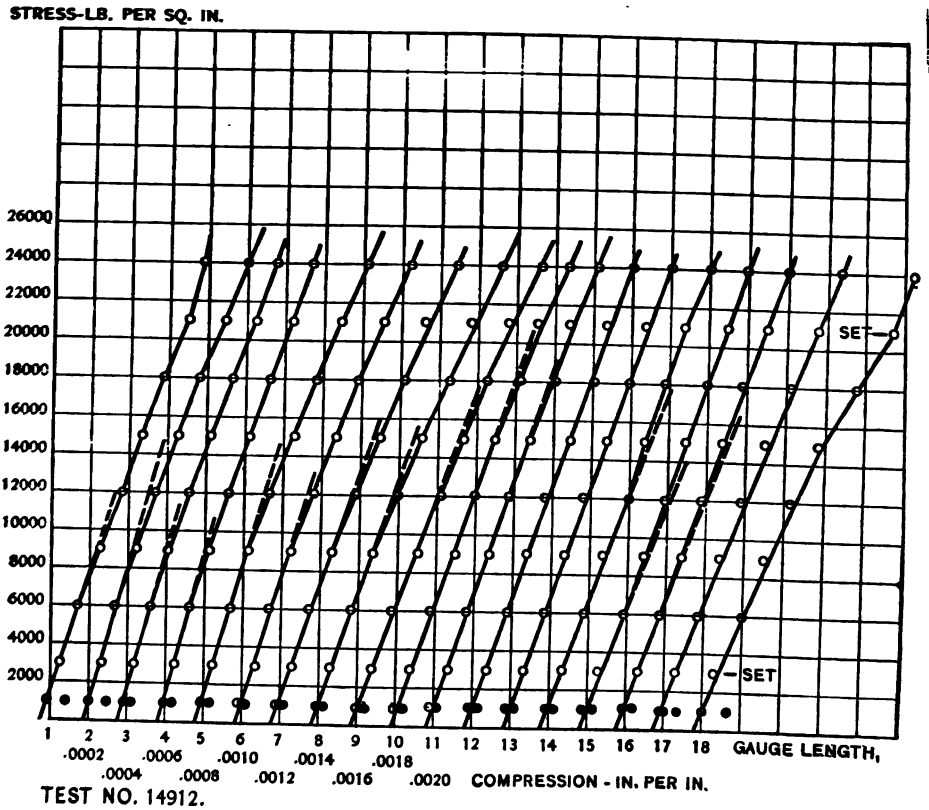

TEST NO. 14911.

COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE D.

No. 14912.

Built I column.
Figure 2, 60,000 lb. carbon steel.
Length of column, 15 ft., 7.60 in.
Weight, 501 lbs.
Sectional area, 9.046 sq. in.
Gauge lengths as per sketch.
Pin ends, figure 3, pins vertical in plane of web.
Length from center to center of pins, 16 ft., 4.30 in.

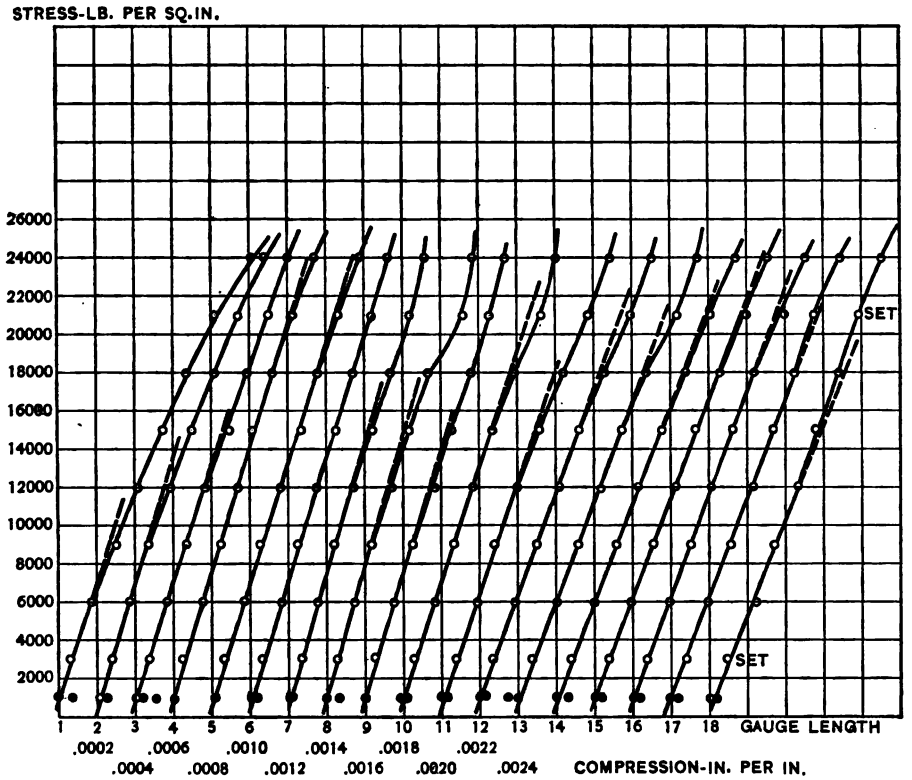
61783°—13——7




COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE A.

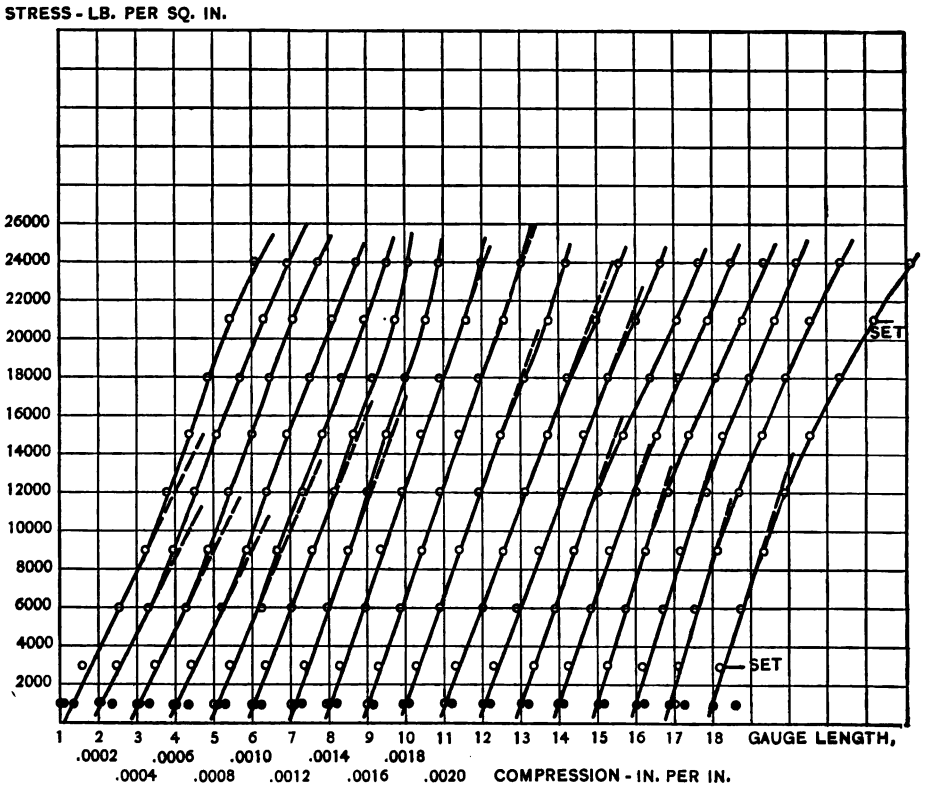
| | 12 | | 13 | |
|---|---|---|---|---|
| mpres-on per nch. | Com-presso-meter reading. | Compres-sion per inch. | Com-presso-meter reading. | Compres-sion per inch. |
| *In.* | *In.* | *In.* | *In.* | *In.* |
| | 0.0056 | 0. | 0.0041 | 0. |
| | .0064 | 0. | .0082 | 0. |
| | .0079 | 0. | .0052 | 0. |
| | .0066 | 0. | .0050 | 0. |
| .00008 | .0064 | .00008 | .0048 | .00007 |
| .00007 | .0070 | .00006 | .0089 | .00007 |
| .00007 | .0086 | .00007 | .0060 | .00006 |
| .00007 | .0072 | .00006 | .0057 | .00007 |
| .00002 | .0057 | .00001 | .0041 | 0. |
| | .0065 | .00001 | .0082 | 0. |
| .00001 | .0079 | 0. | .0053 | .00001 |
| | .0065 | −.00001 | .0051 | .00001 |
| .00017 | .0074 | .00018 | .0059 | .00018 |
| .00018 | .0082 | .00018 | .0102 | .00020 |
| .00021 | .0098 | .00019 | .0071 | .00019 |
| .00018 | .0081 | .00015 | .0066 | .00016 |
| .00028 | .0084 | .00028 | .0068 | .00027 |
| .00027 | .0093 | .00029 | .0113 | .00031 |
| .00031 | .0110 | .00031 | .0081 | .00029 |
| .00028 | .0092 | .00026 | .0076 | .00026 |
| .00038 | .0094 | .00038 | .0078 | .00037 |
| .00039 | .0105 | .00041 | .0125 | .00043 |
| .00043 | .0122 | .00043 | .0094 | .00042 |
| .00039 | .0102 | .00036 | .0086 | .00036 |
| .00048 | .0105 | .00049 | .0089 | .00048 |
| .00051 | .0116 | .00052 | .0136 | .00054 |
| .00055 | .0133 | .00054 | .0106 | .00054 |
| .00049 | .0112 | .00046 | .0094 | .00044 |
| .00060 | .0116 | .00060 | .0100 | .00059 |
| .00064 | .0129 | .00065 | .0149 | .00067 |
| .00066 | .0145 | .00066 | .0120 | .00068 |
| .00058 | .0121 | .00055 | .0104 | .00054 |
| .00069 | .0124 | .00068 | .0109 | .00068 |
| .00077 | .0143 | .00079 | .0165 | .00083 |
| .00080 | .0160 | .00081 | .0134 | .00082 |
| .00067 | .0128 | .00062 | .0111 | .00061 |
| .00003 | .0060 | .00004 | .0044 | .00003 |
| .00003 | .0067 | .00008 | .0087 | .00005 |
| .00004 | .0082 | .00003 | .0056 | .00004 |
| .00003 | .0068 | .00002 | .0052 | .00002 |
| .00081 | .0136 | .00080 | .0121 | .00080 |
| .00088 | .0154 | .00090 | .0176 | .00094 |
| .00092 | .0172 | .00093 | .0146 | .00094 |
| .00081 | .0140 | .00074 | .0123 | .00073 |

per sq. in. was reached when



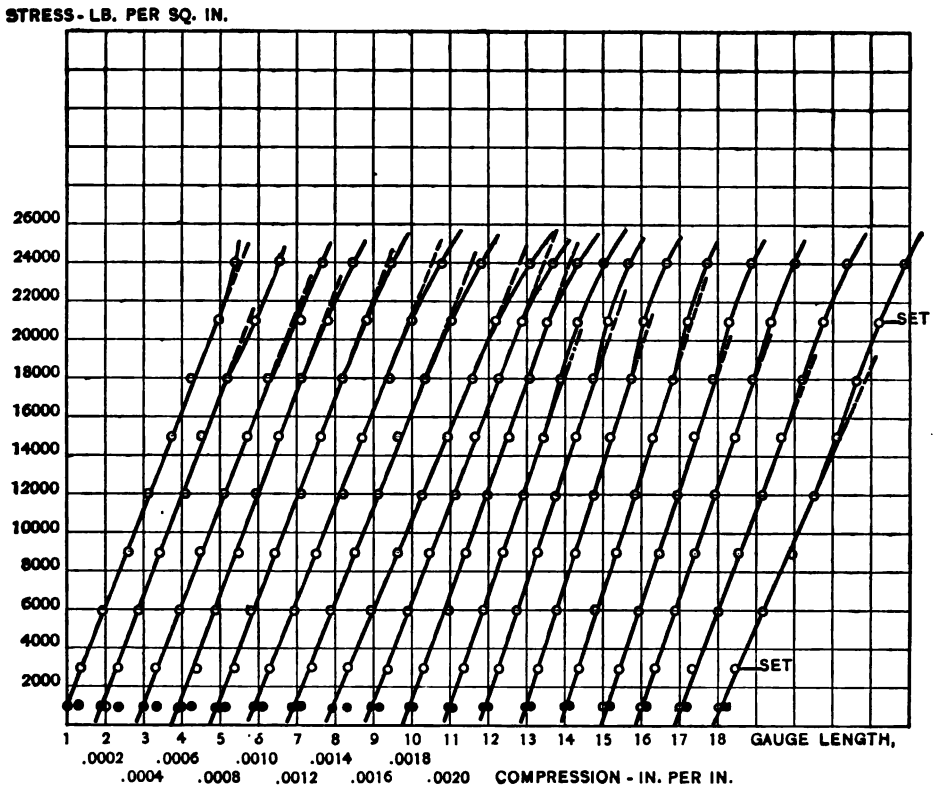

TEST NO. 14912

COMPRESSIVE TEST OF STEEL COLUMN
ANGLE B




TEST NO. 14912.

COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE C.



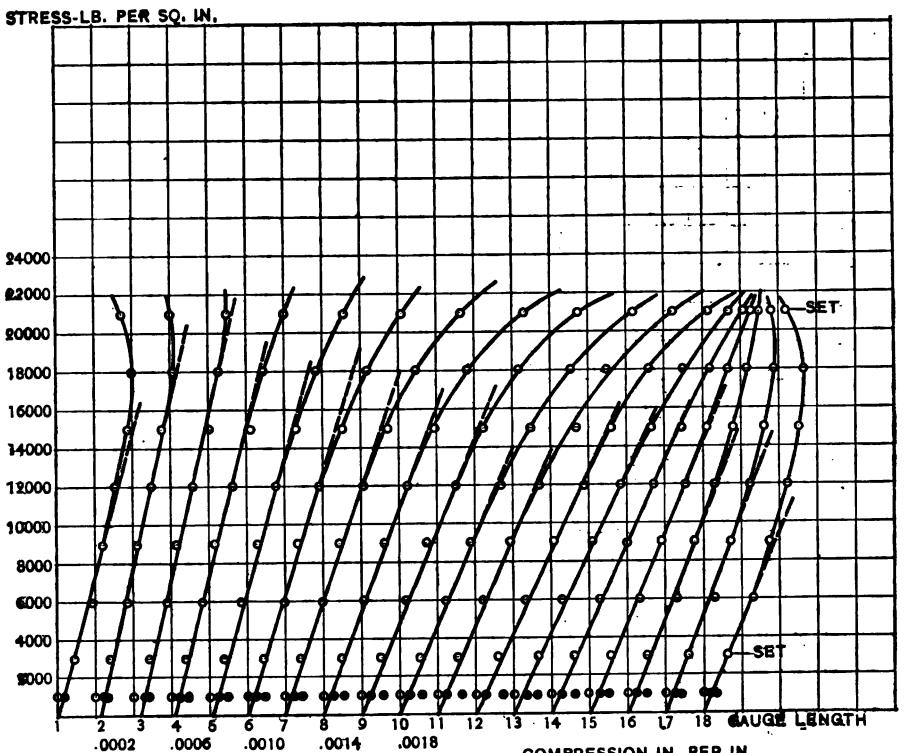

TEST NO. 14912

COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE D.

No. 14913.

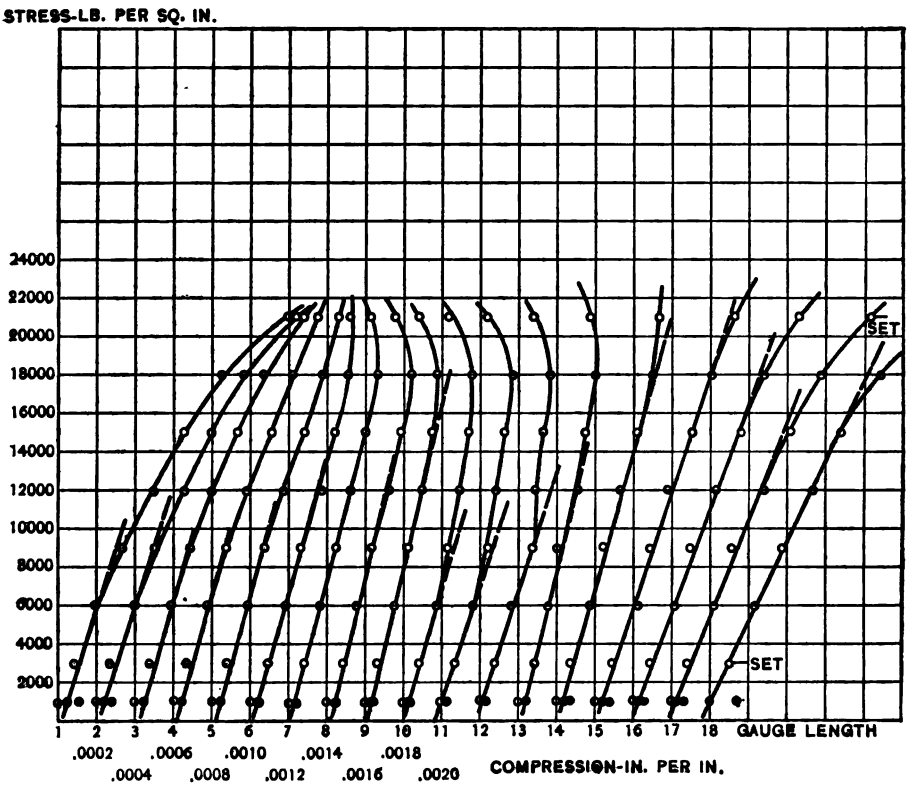
Built I column.
Figure 2, 60,000 lb. carbon steel.
Length of column, 15 ft. 7.60 in.
Weight, 497 lbs.
Sectional area, 8.971 sq. in.
Gauge lengths as per sketch.
Pin ends, figure 3, pins vertical in plane of web.
Length from center to center of pins, 16 ft. 4.30 in.

| 1 | 12 | | 13 | |
|---|---|---|---|---|
| ompression per inch. | Compresso-meter reading. | Compression per inch. | Compresso-meter reading. | Compression p inch |
| *In.* | *In.* | *In.* | *In.* | *In.* |
| 0. | 0.0072 | 0. | 0.0036 | 0. |
| 0. | .0037 | 0. | .0051 | 0. |
| 0. | .0016 | 0. | .0032 | 0. |
| 0. | .0070 | 0. | .0063 | 0. |
| .00010 | .0083 | .00011 | .0049 | .000 |
| .00007 | .0044 | .00007 | .0059 | .000 |
| .00007 | .0022 | .00006 | .0038 | .000 |
| .00012 | .0081 | .00011 | .0075 | .000 |
| .00004 | .0076 | .00004 | .0042 | .000 |
| .00004 | .0040 | .00003 | .0054 | .000 |
| .00002 | .0018 | .00002 | .0033 | .000 |
| .00005 | .0074 | .00004 | .0068 | .000 |
| .00025 | .0099 | .00027 | .0063 | .000 |
| .00016 | .0052 | .00015 | .0066 | .000 |
| .00015 | .0029 | .00013 | .0045 | .000 |
| .00026 | .0096 | .00026 | .0087 | .000 |
| .00038 | .0113 | .00041 | .0077 | .000 |
| .00023 | .0064 | .00027 | .0072 | .000 |
| .00023 | .0036 | .00020 | .0052 | .000 |
| .00041 | .0110 | .00040 | .0102 | .000 |
| .00053 | .0128 | .00056 | .0092 | .000 |
| .00028 | .0066 | .00029 | .0081 | .000 |
| .00029 | .0043 | .00027 | .0060 | .000 |
| .00057 | .0124 | .00054 | .0111 | .000 |
| .00073 | .0144 | .00072 | .0109 | .000 |
| .00032 | .0070 | .00033 | .0086 | .000 |
| .00033 | .0048 | .00032 | .0066 | .000 |
| .00073 | .0140 | .00070 | .0128 | .000 |
| .00090 | .0164 | .00092 | .0126 | .000 |
| .00036 | .0073 | .00036 | .0091 | .000 |
| .00034 | .0050 | .00034 | .0071 | .000 |
| .00092 | .0159 | .00089 | .0144 | .000 |
| .00124 | .0195 | .90123 | .0150 | .001 |
| .00024 | .0065 | .00028 | .0089 | .000 |
| .00023 | .0042 | .00026 | .0068 | .000 |
| .00125 | .0192 | .00122 | .0169 | .001 |
| .00012 | .0085 | .00013 | .0047 | .000 |
| .00001 | .0038 | .00001 | .0054 | .000 |
| .00001 | .0016 | 0. | .0032 | 0. |
| .00011 | .0081 | .00011 | .0072 | .000 |

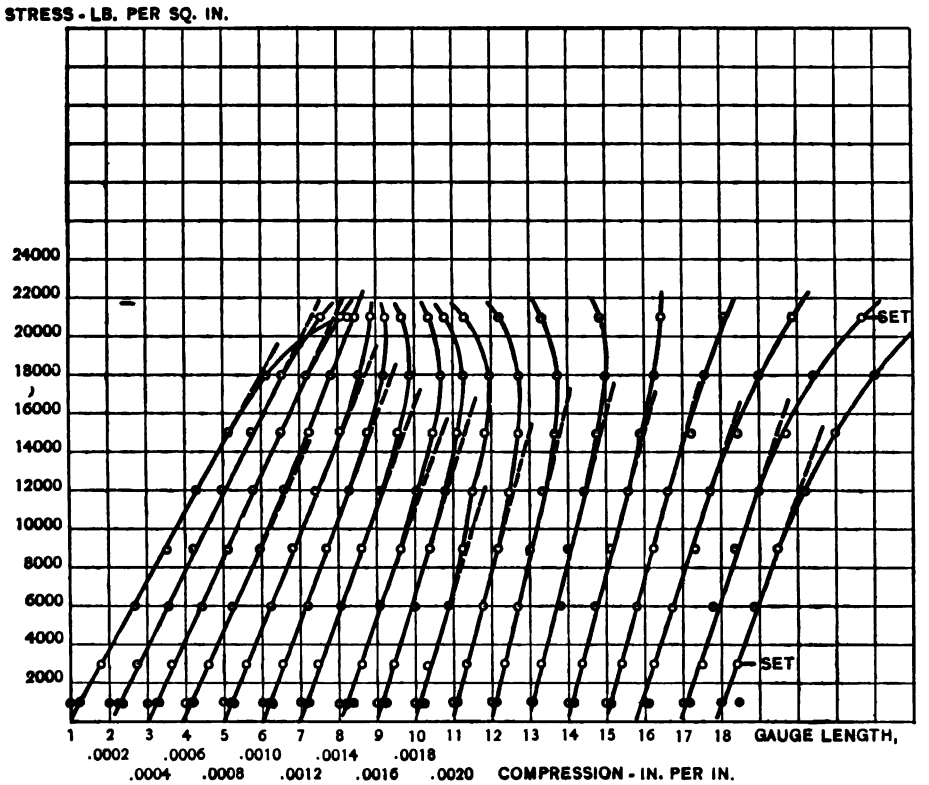



TEST NO. 1491 3

COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE A.

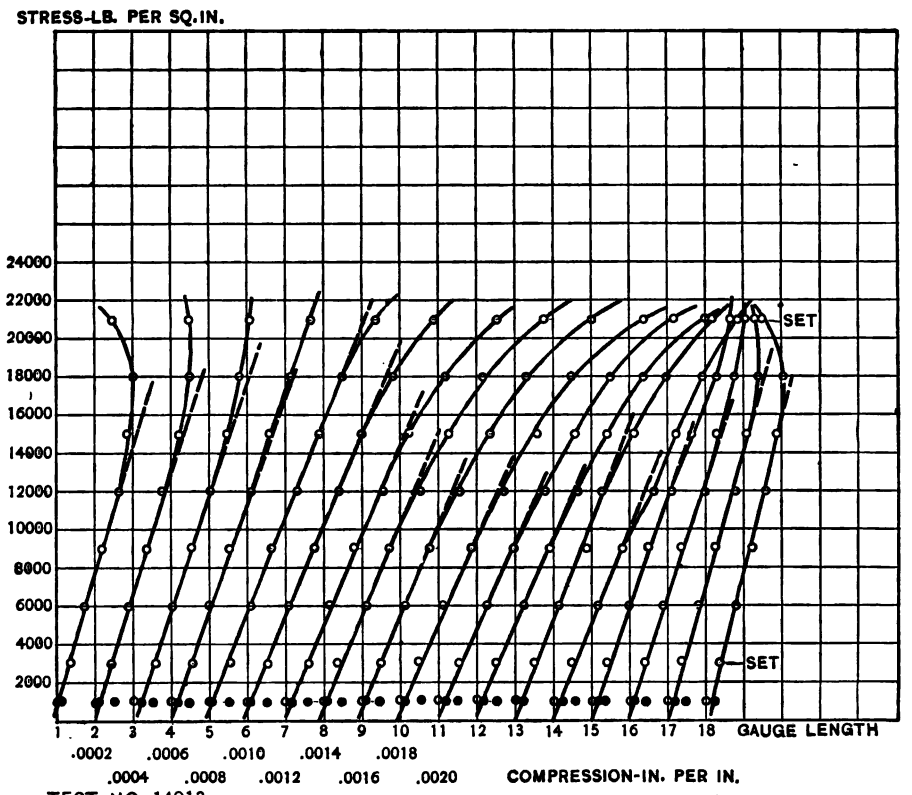



TEST NO. 14913 COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE B.




TEST NO. 14913

COMPRESSIVE TEST OF STEEL COLUMN.
ANGLE C.




COMPRESSIVE TEST OF STEEL COLUMN
ANGLE D

# SPRINGS FOR ORDNANCE WORK.

## TEST 14688.

*TESTS OF HELICAL SPRINGS FOR WATERTOWN ARSENAL, MASS., ON P. O. 9245.*

2 pawl springs. Dg. 12–14–10.
Springs first closed solid 100 times.

| Outside diameter solid. | Inside diameter free. | Solid height. | Load at 3.83 inches. | Free height before test. | Free height after test. |
|---|---|---|---|---|---|
| *In.* | *In.* | *In.* | *Lb.* | *In.* | *In.* |
| 1.312 | 1 | 2.187 | 50 | ..... | ..... |
| 1.3 | 1 | 2.05 | 49½ | 6.2 | 6.1 |
| 1.3 | 1 | 2.05 | 50½ | 6.15 | 6.07 |

Springs closed solid for 48 hours, then retested.

| | | | | | |
|---|---|---|---|---|---|
| 1.3 | 1 | 2.05 | 50 | 6.2 | 6.1 |
| 1.3 | 1 | 2.05 | 51 | 6.15 | 6.07 |

10 springs (2B). Drawing 72–1–3.

Tested after closing solid 100 times.

| No. | Free height. | Load at assembled height of 1.625 inches. | Load at solid height of 1.32 inches. | Outside diameter. | Free height. | |
|---|---|---|---|---|---|---|
| | | | | | Before test. | Set. |
| | *In.* | *Lb.* | *Lb.* | *In.* | *In.* | *In.* |
| 1 | 2.05 | 69 | 119 | 0.76 | 2.08 | 0.03 |
| 2 | 2.07 | 69 | 121 | .76 | 2.08 | .01 |
| 3 | 2.06 | 66½ | 119 | .76 | 2.07 | .01 |
| 4 | 2.07 | 69 | 119 | .76 | 2.07 | .00 |
| 5 | 2.05 | 64½ | 114 | .76 | 2.09 | .04 |
| 6 | 2.14 | 74 | 124 | .76 | 2.15 | .01 |
| 7 | 2.05 | 64 | 114 | .76 | 2.07 | .02 |
| 8 | 2.09 | 67½ | 118 | .76 | 2.10 | .01 |
| 9 | 2.12 | 73 | 121 | .76 | 2.15 | .03 |
| 10 | 2.06 | 64½ | 116 | .76 | 2.08 | .02 |

Retest after closing solid 48 hours.

| No. | Free height. | Load at assembled height of 1.625 inches. | Load at solid height of 1.32 inches. | Outside diameter, | Total set. |
|---|---|---|---|---|---|
| | *In.* | *Lb.* | *Lb.* | *In.* | *In.* |
| 1 | 2.05 | 64 | 110 | 0.76 | 0.03 |
| 2 | 2.04 | 63½ | 111 | .76 | .04 |
| 3 | 2.06 | 66 | 114½ | .76 | .01 |
| 4 | 2.06 | 65½ | 113 | .76 | .01 |
| 5 | 2.03 | 60 | 108 | .76 | .06 |
| 6 | 2.11 | 72 | 120 | .76 | .04 |
| 7 | 2.03 | 61 | 109 | .76 | .04 |
| 8 | 2.07 | 65 | 112 | .76 | .03 |
| 9 | 2.08 | 70 | 117 | .76 | .07 |
| 10 | 2.04 | 61 | 108½ | .76 | .04 |

## TEST 14714.

*TESTS OF 56-PAWL SAFETY LATCH SPRINGS, FOR 8-IN. D. C., MODEL 1896. DRAWING 8-9-8. REVISION OF MARCH 31, 1909.*

Outside diameter, 1 in.
Free length, 8.5 in.
Inside diameter of hooks, 0.6 in.
Load at 0.75-in. extension, 20-lb. min., 22–30 lb.
Load at 2.50-in. extension, 65-lb. min., 75–80 lb.
Springs extended 2.5 in. 100 times before test with no set.

## TEST No. 14743.

*RETEST OF TWO PAWL SPRINGS, DRAWING 11-5-54, RECEIVED FROM SANDY HOOK PROVING GROUND, FOR 14 IN. D. C., MODEL OF 1897.*

September 26, 1911, measurements when received:

Assembled height, 3.75 in.—40 lb. minimum required load; right spring, 19 lb. 9 oz.; left spring, 9 lb. 7 oz.

Solid height, 2 in.—60 lb. minimum rquired load; right spring, 61 lb. 8 oz.; left spring, 45 lb.

Free height—left spring, 4.3 in.; right spring, 4.9 in.

September 28, 1911, measurements after springs had been closed solid for 48 hours:

At assembled height—left spring, 8 lb. 15 oz.; right spring, 19 lb. 4 oz.

At solid height—left spring, 44 lb.; right spring, 59 lb. 4 oz.

Springs then closed solid 100 times:

At assembled height—left, 8 lb. 15 oz.; right, 19 lb. 3 oz.

At solid height—left, 44 lb.; right, 59 lb. 2 oz.

Free height after tests—right, 4.88 in.; left, 4.3 in.

The above springs appear to have been subjected to a large overload which caused the coils to overlap one another, thus straining the fibers in such a way as to cause a large permanent set, which effect could not be obtained without greatly overloading the springs.

Required: Approximate diameter of wire, 0.125 in.

Assembled height, 3.75 in. under not less than 40 lb.

Solid height, not over 2 in. under not less than 60 lb.

Outside diameter, not over 1.312 ($1\frac{5}{16}$) in.

*COMPRESSIVE TEST OF BUFFER SPRINGS FOR 8-IN. AMMUNITION TRUCK.*

Tested for acceptance. Quantity, 117. P. O. 848.

RESULTS OF TESTS OF SPRINGS.

Free height, from 7.44 to 7.78 in.
Outside diameter when closed down: Maximum, 2.12 in. (2 springs); minimum, 2.07 in. (5 springs).
Minimum inside diameter, 1.65 in.
Load at height of 4.75 in., from 58 to 74 lb.
Solid height, from 2.31 to 2.48 in.
Load at solid height, from 116 to 140 lb.

REQUIREMENTS.

Free height, 7.25 in.
Maximum outside diameter, 2.10 in.
Minimum inside diameter, 1.65 in.
To sustain 60 lb. at assembled height of 4.75 in.
Capacity, 120 lb. at solid height of 2.50 inches approximately.

## TEST 14839.

*COMPRESSIVE TESTS OF LATCH SPRINGS FOR WATERTOWN ARSENAL, MASS.*

Number of springs, 28.
Outside diameter, maximum at solid height, 0.425 in.
Solid height, 1.80 to 1.95 in.
Height under 20 lb., 2.81 to 3.02 in.
Required: Outside diameter, maximum at solid height, 0.437 in. Solid height not over 2.25 in. Assembled height under 20 lb., 3 in.

## TEST 14849.

*COMPRESSIVE TESTS OF FRICTION SPRINGS FOR 15-POUNDER B. C., MODEL 1903, DRAWING 5-15-7, FOR WATERTOWN ARSENAL.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* |
| Inside diameter | 0.635 | 0.635 | 0.635 | 0.635 | 0.635 | 0.635 | 0.635 | 0.635 |
| Free height | 2.30 | 2.30 | 2.30 | 2.30 | 2.30 | 2.28 | 2.33 | 2.28 |
| Load at height of 2.13 in. | [1] 390 | [1] 442 | [1] 389 | [1] 399 | [1] 425 | [1] 333 | [1] 444 | [1] 317 |
| Height at load of 511 lb. | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.07 | 2.10 | 2.07 |
| Load at height of 1.87 in. | [1] 1,087 | [1] 1,112 | [1] 1,117 | [1] 1,176 | [1] 1,155 | [1] 1,085 | [1] 2,498 | [1] 1,028 |
| Height at load of 1,279 lb. | 1.86 | 1.84 | 1.87 | 1.86 | 1.87 | 1.82 | 1.90 | 1.83 |
| Final free height | 2.30 | 2.30 | 2.30 | 2.30 | 2.30 | 2.28 | 2.33 | 2.28 |

[1] Pounds.

### REQUIREMENTS.

Inside diameter, 0.635 in. ± 0.01. Free height = 2.3 in.
Initial height under 511 lb. = 2.13 in.
Solid height under 1,279 lb. = 1.875 in.

## TEST 14856.

*COMPRESSIVE TESTS OF ELEVATING SLIDE SPRINGS FOR 6-IN. D. C., MODEL 1905, FOR WATERTOWN ARSENAL, MASS.*

Number of springs, 6.

Springs closed solid for 48 hours: Decrease in free height—Maximum, 0.26 in.; average, 0.22 in.; minimum, 0.17 in.

Springs closed solid 100 times: Decrease in free height—Maximum, 0.01 in.; average, 0.005 in.; minimum, 0.0 in.

| | Required. | Tested. |
|---|---|---|
| Minimum inside diameter | 3.75 in | Maximum, 3.75 in.<br>Average, 3.74 in.<br>Minimum, 3.72 in. |
| Free height | 12.8 in | Maximum, 13.03 in.<br>Average, 12.99 in.<br>Minimum, 12.90 in. |
| Height under 2,000 lb | 10.5 in | Maximum, 10.94 in.<br>Average, 10.90 in.<br>Minimum, 10.86 in. |
| Load at 10.5 in | 2,000 lb | Maximum, 2,500 lb.<br>Average, 2,500 lb.<br>Minimum, 2,400 lb. |
| Load at 8 in | Over 4,000 lb | Maximum, 5,600 lb.<br>Average, 5,560 lb.<br>Minimum, 5,500 lb. |
| Solid height | Under 8 in | Maximum, 7.90 in.<br>Average, 7.87 in.<br>Minimum, 7.80 in. |

## TEST 14855.

*COMPRESSIVE TESTS OF BUFFER SPRINGS FOR 12-IN. D. C., MODEL 1896, FOR WATERTOWN ARSENAL, MASS.*

Number of springs, 81.

Springs closed down 48 hours: Maximum decrease in free height, 0.29 in.; minimum decrease in free height, 0.07 in.; average decrease in free height, 0.195 in.

Closed solid 100 times: Maximum decrease, 0.18 in.; minimum decrease, 0.00 in.; average decrease, 0.065 in.

*Test of springs.*

| | Required. | Tested. |
|---|---|---|
| Solid height at 120 lb | Under 2.07 in | Maximum, 1.98 in.<br>Minimum, 1.90 in. |
| Assembled height at 60. lb or over | 4.5 in. | Maximum, 4.80 in.<br>Minimum, 4.50 in. |
| Inside diameter, free | Not under 1.69 in. | 1.69 in. |
| Outside diameter | Under 2.05 in | Maximum, 2.07 in. (2–2.07 in.).<br>(5–2.06 in.).<br>Minimum, 2.05 in. |

## TEST 14896.

*COMPRESSIVE TESTS OF TWO BUFFER SPRINGS FOR 14-IN. D. C., L. F., MODEL 1907, FOR WATERTOWN ARSENAL, MASS.*

Number of springs, 2.
Buffer springs, flat.

| | Required. | Spring A. | Spring B. |
|---|---|---|---|
| Inside diameter, free | 4.50 in. | 4.50 in. | 4.52 in. |
| Load at height of 11.21 in | | 1,183 lb. | 2,055 lb. |
| Height at load of 1,840 lb | 11.208 in. | 6.57 in. | 11.86 in. |
| Load at height of 6.125 in | | 1,783 lb. | 12,342 lb. |
| Height at load of 2,800 lb | | 5.28 in. | 9.22 in. |
| Height when solid | Not over 6.125 in. | 5.25 in. | 6.125 in. |
| Load when solid | | 3,438 lb. | 12,342 lb. |
| Maximum outside diameter solid | Under 8.375 in. | 7.92 in. | 7.80 in. |

All springs to have approximately the same load at solid height.

## TEST 14909.

*TENSILE TESTS OF CROSSHEAD PAWL SPRINGS FOR 10-IN. D. C., L. F., MODEL 1901, FOR WATERTOWN ARSENAL, MASS.*

Number of springs, 25.

Free length: Maximum, 6.73 in.; minimum, 6.60 in.

Free length taken 0.30 in. from inside of hook at each end.

Six springs from lot extended 0.8 in. 100 times and returned to their original length without set.

Extension of springs at load of 105 lb.: Required, 0.33 in.; maximum, 0.31 in.; minimum, 0.21 in.

Extension of springs at load of 262 lb.: Required, 0.83 in.; maximum, 0.83 in.; minimum, 0.76 in.

Final free length: Maximum, 6.73 in.; minimum, 6.60 in.

Diameter at inside of hooks: Required, 0.60 in.; maximum, 0.56 in.; minimum, 0.51 in.

## TEST 14920.

### *COMPRESSIVE TESTS OF OUTER AND INNER SPRINGS FOR 6-IN. B. C., MODEL 1910, FOR WATERTOWN ARSENAL, MASS.*

OUTER SPRING.

| | In. |
|---|---|
| Free height | 21.35 |
| Free height after being closed down 50 hours | 19.25 |
| Free height after being compressed 100 times | 18.90 |

TEST OF SPRING.

| | Required. | Results. |
|---|---|---|
| Load at height of 15.916 in | Not less than 2,216 lb | 880 lb. |
| Solid height | Not more than 10.25 in | 9.65 in. |
| Inside diameter, free | Not less than 4.902 in | 4.92 in. |
| Outside diameter, solid | Not more than 6.908 in | 6.80 in. |
| Final free height | | 18.88 in. |

INNER SPRING.

| | In. |
|---|---|
| Free height | 22.17 |
| Free height after being closed down 50 hours | 21.00 |
| Free height after being compressed 100 times | 20.90 |

TEST OF SPRING.

| | Required. | Results. |
|---|---|---|
| Load at height of 15.916 in | Not less than 1,072 lb | 360 lb. |
| Solid height | Not more than 10.25 in | 10.10 in. |
| Inside diameter, free | Not less than 3.391 in | 3.50 in. |
| Outside diameter, solid | Not more than 4.82 in | 4.63 in. |
| Final free height | | 20.93 in. |

## TEST 14931.

*COMPRESSIVE TEST OF SPRINGS FOR 4.72-IN. DUMMY PROJECTILES FOR WATERTOWN ARSENAL.*

| | Required. | Results. |
|---|---|---|
| Free height | 0.85 in | Maximum, 0.87 in.<br>Minimum, 0.82 in. |
| Load at height of 0.70 in | 4.25 lb | Maximum, 5.25 lb.<br>Minimum, 3.75 lb. |
| Load at height of 0.462 in | 10.94 lb | Maximum, 13.0 lb.<br>Minimum. 11.0 lb. |
| Height when solid | .462 in | Maximum, 0.41 in.<br>Minimum, 0.38 in. |
| Outside diameter | .31 in | 0.31 in. |
| Final free height | | Maximum, 0.87 in.<br>Minimum, 0.82 in. |

## TEST 14932.

*COMPRESSIVE TEST OF SPRINGS FOR 6-IN. DUMMY PROJECTILES FOR WATERTOWN ARSENAL, MASS.*

| | Required. | Results. |
|---|---|---|
| Free height | 2.125 in. | Maximum, 2.10 in.<br>Minimum, 2.06 in. |
| Load at height of 1.535 in | 16.55 lb. | Maximum, 15.75 lb.<br>Minimum, 14.25 lb. |
| Load at height of 1.276 in | 23.8 lb. | Maximum, 23 lb.<br>Minimum, 21 lb. |
| Height when solid | 1.276 in. | Maximum, 1.25 in.<br>Minimum, 1.20 in. |
| Outside diameter | 0.375 in. | 0.375 in. |
| Final free height | | Maximum, 2.10 in.<br>Minimum, 2.06 in. |

## TEST 14933.

*COMPRESSIVE TEST OF SPRINGS FOR 10-IN. DUMMY PROJECTILES FOR WATERTOWN ARSENAL, MASS.*

| | Required. | Results. |
|---|---|---|
| Free height | 2.03 in. | Maximum, 2.14 in.<br>Minimum, 2.06 in. |
| Load at height of 1.625 in. | 58.7 lb. | Maximum, 89 lb.<br>Minimum, 70 lb. |
| Load at height of 1.32 in. | 103 lb. | Maximum, 137.50 lb.<br>Minimum, 121.75 lb. |
| Height when solid | 1.32 in. | Maximum, 1.16 in.<br>Minimum, 1.07 in. |
| Outside diameter | 0.75 in. | 0.75 in. |
| Final free height | | Maximum, 2.14 in.<br>Minimum, 2.06 in. |

## TEST 14915.

*COMPRESSIVE TEST OF A COUNTER-RECOIL SPRING, 12-IN. M. C., MODEL 1896 M1. INNER SPRING.*

Coiled right hand. P. O. 7792. Draw. 12–12–4.

INCREASING LOAD.

| | Required. | Obtained. |
|---|---|---|
| Free height | | 13.75 in. |
| Height at load of 3,800 lb | | 13.18 in. |
| Load at height of 12.65 in | | 6,600 lb. |
| Height when solid | Under 10 in | 9.78 in. |
| Load when solid | | 20,900 lb. |

DECREASING LOAD.

| | | |
|---|---|---|
| Load at height of 12.65 in | 3,800 lb | 2,800 lb. |
| Final free height | | 13.35 in. |
| Interior diameter free | Over 2.875 in | 2.98 in. |

## TEST 14935.

*COMPRESSIVE TEST OF COUNTER-RECOIL SPRINGS FOR 12-IN. M. C., MODEL 1896 M1, FOR WATERTOWN ARSENAL, MASS.*

Inner spring No. 57 received from storehouse.
Inner spring coiled right hand.

INCREASING LOAD.

| | Required. | Results. |
|---|---|---|
| Free height | | 14.82 in. |
| Load at height of 12.65 in. (assembled height) | To sustain a load of 3,800 lb | 8,900 lb. |
| Solid height | Not to exceed 10 in. | 9.95 in. |
| Load at solid height | | 21,700 lb. |
| Exterior diameter when solid | 5.625 in. | 5.48 in. |

DECREASING LOAD.

| | | |
|---|---|---|
| Load at height of 12.65 in. (assembled height) | To sustain a load of 3,800 lb | 5,900 lb. |
| Final free height | | 14.50 in. |
| Interior diameter free | Not less than 2.875 in. | 2.98 in. |

# STEEL CASTINGS FOR ORDNANCE WORK.

## CAST STEEL FROM WATERTOWN ARSENAL STEEL PLANT.

| Heat No. | Grade. | Chemical composition. | | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon. | Manganese. | | | | | | Shore. | Brinell. | |
| | | *Per cent.* | *Per cent.* | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* | | | |
| 3044 | 3 | 0.41 | 0.99 | 46,000 | 85,500 | 24.0 | 30.7 | 0.29*,0.19 | 25.0 | ..... | Silky. |
| 3045 | 3 | .38 | .93 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3046 | 2, 1 1 | .36 | .77 | 43,000 | 79,500 | 13.0 | 13.2 | .15*, .11 | 25.0 | ..... | Fine granular. |
| 3047 | | | | 76,470 | 81,250 | 24.5 | 31.0 | .28*, .21 | 25.0 | ..... | Silky trace of granulation. |
| 3048 | 2,3 | .34 | .88 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3050 | 3 | .40 | .83 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3051 | 3 | .34 | .86 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3052 | 3 | .39 | .76 | 53,500 | 94,000 | 19.5 | 27.4 | .16, .23* | 27.0 | ..... | Dull silky. |
| 3053 | 1,3 | .34 | .83 | 53,300 | 91,800 | 15.5 | 16.9 | .17*, .14 | ..... | ..... | Fine granular, 60 per cent; amorphous, 40 per cent. |
| 3054 | | | | 52,000 | 91,500 | 15.5 | 16.9 | .18*, .13 | 25.5 | ..... | Dull silky, 80 per cent; granular, 20 per cent. |
| 3055 | 2 | .33 | .74 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3057 | 2, 3 | .42 | .75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3058 | 3 | .35 | .79 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3059 | 3 | .45 | .74 | 45,000 | 81,500 | 25.0 | 30.7 | .22, .28* | 25.0 | ..... | Dull silky. |
| 3060 | ..... | .42 | .85 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3061 | 2,1 1 | .40 | .74 | 56,000 | 88,000 | 18.5 | 24.0 | .21*, .16 | 26.5 | ..... | Amorphous. |
| 3062 | | | | | | | | | | | |
| 3063 | 2 | .36 | .74 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3065 | 2,3 | .36 | .82 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3066 | 3 | .38 | .90 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3067 | 3 | .39 | .72 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3068 | 2 | .39 | .73 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3069 | 2 | .35 | .81 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3070 | 2,3 | .37 | .75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3071 | 2,3 | .32 | .72 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3072 | 3 | .42 | .83 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3073 | 3 | .39 | .83 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3074 | 2 | .44 | .74 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3075 | 2 | .37 | .89 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3076 | 2 | .31 | .89 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3077 | 2 | .36 | .78 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3078 | 2 | .36 | .74 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3079 | 3 | .41 | .81 | 50,500 | 103,000 | 21.0 | 37.1 | .28*, .14 | 28.0 | ..... | Amorphous, 40 per cent; fine granular, 60 per cent. |
| 3080 | 3 | .42 | .83 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3081 | 3 | .41 | .78 | 59,500 | 88,000 | 9.5 | 13.2 | .08, .11* | 28.0 | ..... | Amorphous trace of granulation. |
| | | | | 46,000 | 86,500 | 21.5 | 24.0 | .23*, .20* | 26.5 | ..... | Dull silky lamellar, 50 per cent; fine granular, 50 per cent. |
| 3082 | 2,3 | .36 | .69 | 46,500 | 86,500 | 19.0 | 20.5 | .20*, .18 | 26.0 | ..... | Fine granular, 70 per cent; amorphous spot, 30 per cent. |
| 3083 | 2,3 | .35 | .71 | 57,500 | 87,500 | 12.5 | 20.5 | .10, .15* | 27.0 | ..... | Amorphous. |
| 3084 | 2 | .39 | .84 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 48,500 | 80,000 | 20.5 | 27.4 | .23*, .18 | 25.0 | ..... | Do. |
| | | | | 44,500 | 86,500 | 22.5 | 30.7 | .25*, .20 | 26.5 | ..... | Amorphous, lamellar. |
| 3085 | 3 | .35 | .81 | 46,000 | 86,000 | 15.0 | 16.9 | .17*, .13 | 26.0 | ..... | Fine granular amorphous spot at circumference. |
| | | | | 52,500 | 91,000 | 20.0 | 27.4 | .18 .22* | ..... | ..... | Silky. |
| 3086 | 2,3 | .32 | .78 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | | | | 61,000 | 94,500 | 11.0 | 13.2 | .10 .12* | 27.0 | ..... | Fine granular. |
| | | | | 64,270 | 93,420 | 9.5 | 15.6 | .08 .11* | 33.0 | ..... | Fine granular, 50 per cent; amorphous, 50 per cent. |
| 3087 | 2,3 | .36 | .78 | 39,500 | 79,000 | 23.5 | 34.0 | .29*, .18 | 25.0 | ..... | Silky trace of granulation. |
| | | | | 45,000 | 86,000 | 19.5 | 24.0 | .19*, .20* | 27.0 | ..... | Lamellar silky, 85 per cent; granular, 15 per cent. |
| 3088 | ..... | .80 | .97 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3089 | 3 | .40 | .64 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3090 | 2 | .33 | .92 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3091 | 2 | .33 | .84 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3093 | 2 | .38 | .84 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3094 | 2 | .40 | .81 | 44,000 | 80,000 | 26.0 | 34.1 | .25*, .27* | 26.0 | ..... | Amorphous trace of granulation. |
| | | | | 44,000 | 80,000 | 24.5 | 34.0 | .29*, .20 | 27.0 | ..... | Dull silky trace of granulation. |
| 3095 | [1] 1,2,3 | .38 | .91 | 49,500 | 85,000 | 22.5 | 27.4 | .25*, .20 | 26.5 | ..... | Dull silky. |
| | | | | 36,500 | 85,000 | 22.0 | 30.7 | .26*, .18 | 26.5 | ..... | Dull silky, 40 per cent; fine granular, 60 per cent. |
| 3096 | [1] 1,2 | .38 | .71 | 59,500 | 95,500 | 17.5 | 24.0 | .19*, .16* | 28.0 | ..... | Dull silky, part lamellar. |
| 3097 | 2,3 | .31 | .77 | 49,000 | 87,000 | 20.0 | 24.0 | .20*, .20 | 26.0 | ..... | Dull silky, 30 per cent; fine granular, 70 per cent. |
| | | | | 43,000 | 77,500 | 26.5 | 37.1 | .26*, .27* | 24.5 | ..... | Silky. |
| 3098 | 3 | .37 | .71 | 54,500 | 84,000 | 21.0 | 24.0 | .22*, .20 | 22.0 | 163 | Amorphous. |
| 3099 | 3 | .33 | .74 | 45,500 | 78,000 | 22.5 | 24.0 | .25*, .20 | 23.5 | ..... | Amorphous lamellar, 50 per cent; fine granular, 50 per cent. |
| 3100 | 3 | .34 | .80 | 47,000 | 81,500 | 22.5 | 27.4 | .24*, .21 | 24.5 | ..... | Silky trace of granulation. |
| 3101 | ..... | .36 | .88 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3102 | 2,3 | .46 | .74 | 48,000 | 98,000 | 20.5 | 30.7 | .24*, .17 | 28.0 | ..... | Dull silky, 80 per cent; fine granular, 20 per cent. |
| 3103 | 3 | .46 | .77 | 45,000 | 80,000 | 24.0 | 34.0 | .21, .27* | 24.0 | ..... | Silky. |
| 3104 | Dies .. | .97 | .92 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3105 | 3 | .39 | .83 | 51,000 | 85,170 | 27.5 | 37.1 | ..... | ..... | ..... | Do. |
| 3106 | 3 | .39 | .84 | 59,500 | 97,000 | 23.0 | 40.3 | .20, .26* | 28.0 | ..... | Do. |
| | | | | 50,950 | 82,330 | 21.0 | 24.2 | .18, .24* | 23.0 | ..... | Amorphous trace of granulation. |
| 3107 | 2,3 | .37 | .86 | 59,500 | 89,500 | 19.5 | 24.0 | .17, .22* | 26.0 | ..... | Silky. |
| | | | | 51,720 | 85,290 | 13.5 | 13.5 | .14*, .13 | 25.0 | ..... | Fine granular. |
| | | | | 47,000 | 87,000 | 21.0 | 24.0 | .21, .21* | 26.5 | ..... | Fine granular amorphous spot at circumference. |
| 3108 | [1] 1,2,3 | .34 | .91 | 63,000 | 88,500 | 10.0 | 13.2 | .11*, .09 | 28.0 | ..... | Amorphous, 50 per cent; fine granular, 50 per cent. |
| | | | | 47,380 | 83,390 | 16.5 | 17.2 | .24*, .19 | 24.0 | ..... | Amorphous, trace of granulation. |
| 3109 | 2 | .36 | .78 | 47,500 | 86,500 | 22.0 | 30.7 | .25*, .19 | 26.5 | ..... | Silky trace of granulation. |
| 3110 | [1] 1,2,3 | .30 | .79 | 49,750 | 85,500 | 23.5 | 30.9 | .23, .24* | 26.0 | ..... | Amorphous, trace of granulation. |
| | | | | 52,000 | 85,500 | 24.0 | 37.1 | .17, .31* | 26.5 | ..... | Dull silky. |
| 3111 | 3 | .37 | .88 | 54,000 | 95,000 | 22.0 | 30.7 | .17, .27* | 26.0 | ..... | Silky. |
| 3112 | 3 | .34 | .83 | 50,500 | 98,000 | 17.0 | 16.9 | .16, .18* | 29.0 | ..... | Fine granular. |
| 3113 | Dies .. | .96 | .97 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3114 | 3 | .32 | .84 | 55,500 | 93,000 | 24.0 | 43.3 | .35*, .13 | ..... | ..... | Fine silky. |
| 3115 | 3 | .42 | 1.09 | 52,000 | 85,000 | 22.5 | 27.4 | .25*, .20* | 23.5 | ..... | Silky. |
| | | | | 50,000 | 87,000 | 17.0 | 16.9 | .17, .17* | 25.5 | ..... | Fine granular amorphous spot at circumference. |
| 3116 | 2 | .34 | 1.01 | 46,000 | 86,500 | 19.0 | 24.0 | .20*, .18 | 27.0 | ..... | Fine granular, lamellar spot. |
| | | | | 45,000 | 81,000 | 24.0 | 30.7 | .19, .29* | 24.0 | ..... | Silky. |
| 3117 | [1] 1,2,3 | .40 | .81 | 45,500 | 83,000 | 24.5 | 37.1 | .24*, .25* | 37.1 | ..... | Dull silky. |
| 3118 | 2,3 | .32 | .86 | 46,000 | 84,000 | 21.5 | 30.7 | .26*, .17 | 24.5 | ..... | Silky trace of granulation. |

[1] Navy.

*Cast steel from Watertown Arsenal steel plant*—Continued.

| Heat No. | Grade. | Chemical composition. | | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon. | Manganese. | | | | | | Shore. | Brinell. | |
| | | *Per cent.* | *Per cent.* | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* | | | |
| 3119 | 3 | 0.38 | 0.91 | 64,000 | 97,500 | 14.0 | 20.5 | 0.12, 0.26* | ..... | ..... | Silky. |
| 3120 | [1] 1, 2, 3 | .41 | .83 | 45,500 | 78,500 | 25.0 | 34.0 | .27*, .23 | 23.0 | ..... | Do. |
| | | | | 55,500 | 91,500 | 19.5 | 30.7 | .15, .24* | ..... | ..... | Dull silky. |
| 3121 | 2, 3 | .31 | .85 | 59,000 | 96,500 | 22.5 | 34.0 | .25*, .20 | ..... | ..... | Silky. |
| 3122 | 3 | .32 | .87 | 67,000 | 104,500 | 19.5 | 34.0 | .24*, .15 | ..... | ..... | Do. |
| 3123 | 3 | .42 | 1.02 | 55,000 | 98,000 | 22.5 | 43.3 | .31*, .14 | 27.5 | ..... | Dull silky. |
| 3124 | 3 | .47 | 1.01 | 55,500 | 90,500 | 25.5 | 40.3 | .25*, .26* | 24.5 | ..... | Silky. |
| 3125 | [1] 1, 2, 3 | .36 | .88 | 34,500 | 82,000 | 23.5 | 27.4 | .25*, .22* | 25.0 | ..... | Dull silky. |
| | | | | 40,500 | 77,500 | 23.5 | 27.4 | .20, .27* | ..... | ..... | Do. |
| | | | | 48,500 | 91,000 | 19.0 | 20.5 | .20*, .18 | 24.0 | ..... | Fine granular, 75 per cent; dull silky, 25 per cent. |
| | | | | 40,800 | 81,000 | 25.0 | 34.0 | .20, .30* | ..... | ..... | Silky, bordering on granular. |
| 3126 | [1] 1, 2, 3 | .37 | .92 | 47,000 | 81,500 | 26.0 | 34.0 | .28*, .24* | 25.0 | ..... | Dull silky. |
| | | | | 47,500 | 91,000 | 20.0 | 27.4 | .17, .23* | ..... | ..... | Do. |
| 3127 | 3 | .46 | .90 | 60,000 | 96,000 | 23.0 | 37.1 | .15, .31* | ..... | ..... | Silky. |
| 3128 | 3 | .39 | .94 | 54,000 | 91,000 | 23.0 | 34.0 | .24*, .22 | 27.0 | ..... | Dull silky. |
| 3129 | [1] 1, 2, 3 | .39 | .91 | 47,500 | 86,500 | 22.0 | 30.7 | .23*, .21 | 26.0 | ..... | Dull silky trace of granulation. |
| 3130 | ..... | .92 | .95 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3131 | 2 | .38 | .76 | 60,000 | 105,500 | 15.0 | 16.9 | .17*, .13 | 29.0 | ..... | Fine granular amorphous spot at circumference. |
| 3132 | 2 | .34 | 1.01 | 49,500 | 85,000 | 15.5 | 24.0 | .13, .18* | 26.0 | ..... | Amorphous. |
| 3133 | 1, 2, 3 | .35 | .97 | 43,000 | 80,000 | 23.0 | 27.4 | .23*, .23* | 25.0 | ..... | Dull silky. |
| | | | | 56,500 | 90,000 | 21.5 | 27.4 | .19, .24* | ..... | ..... | Fine silky. |
| 3134 | [1] 1, 2, 3 | .33 | .83 | 40,000 | 77,500 | 25.0 | 37.1 | .29*, .21 | ..... | ..... | Silky. |
| | | | | 48,500 | 91,000 | 21.5 | 30.7 | .18, .25* | 25.0 | ..... | Fine granular, 20 per cent; dull silky, 80 per cent. |
| | | | | 42,500 | 77,500 | 28.0 | 37.1 | .24, .32* | ..... | ..... | Dull silky. |
| 3135 | 1, 2, 3 | .33 | .88 | 53,500 | 89,500 | 16.0 | 16.9 | .18*, .14 | ..... | ..... | Amorphous, 20 per cent; granular, 80 per cent. |
| | | | | 45,500 | 88,500 | 21.5 | 30.7 | .17, .26* | 22.0 | ..... | Dull silky trace of granulation. |
| 3136 | 3 | .34 | .83 | 53,500 | 87,500 | 23.0 | 37.1 | .19, .27* | 26.0 | ..... | Dull silky. |
| 3137 | 3 | .36 | .90 | 51,000 | 87,000 | 24.5 | 37.1 | .32*, .17 | 25.0 | ..... | Silky. |
| 3138 | [1] 1, 2, 3 | .40 | .87 | 48,500 | 82,500 | 27.5 | 37.1 | .24, .31* | ..... | ..... | Dull silky. |
| | | | | 52,000 | 87,500 | 23.5 | 37.1 | .17, .30* | ..... | ..... | Do. |
| 3139 | 3 | .38 | .75 | 59,500 | 106,500 | 20.0 | 37.1 | .28*, .12 | ..... | ..... | Do. |
| 3140 | 1, 2 | .37 | .90 | 38,500 | 79,000 | 26.5 | 34.0 | .33*, .20 | ..... | ..... | Dull silky trace of granulation. |
| | | | | 39,800 | 79,000 | 25.5 | 37.1 | .26*, .25* | ..... | ..... | Do. |
| 3141 | 2, 3 | .38 | .81 | 40,500 | 75,800 | 27.5 | 37.1 | .34*, .21 | ..... | ..... | Silky. |
| | | | | 50,500 | 85,500 | 25.0 | 40.3 | .27*, .23 | ..... | ..... | Do. |
| 3142 | 1, 2 | .36 | .75 | 40,000 | 78,500 | 26.5 | 34.0 | .26, .27* | ..... | ..... | Dull silky trace of granulation. |
| 3143 | 2, 3 | .39 | .68 | 44,800 | 82,500 | 21.5 | 27.4 | .19, .24* | ..... | ..... | Dull silky oblique. |
| | | | | 56,500 | 93,000 | 17.5 | 16.9 | .20*, .15 | ..... | ..... | Fine granular, 50 per cent; amorphous, 50 per cent. |
| | | | | 46,800 | 88,000 | 20.0 | 27.4 | .16, .24* | 24.0 | ..... | Dull silky, 50 per cent; granular, 50 per cent. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3144 | 1,2,3 | .42 | .68 | 47,500 | 86,000 | 19.5 | 24.0 | .18, .21* | ..... | ..... | Fine granular, 90 per cent; silky, 10 per cent. |
| 3145 | 2,3 | .40 | .78 | 45,500 | 79,500 | 24.5 | 30.7 | .18, .31* | ..... | ..... | Dull silky granular spots, slightly oblique fracture. |
| | | | | 59,000 | 89,500 | 21.5 | 27.4 | .25*, .18 | ..... | ..... | Dull silky. |
| 3146 | 2 | .36 | .65 | 36,000 | 75,000 | 24.5 | 40.3 | .33*, .16 | ..... | ..... | Silky. |
| 3147 | 2 | .37 | .75 | 60,000 | 104,000 | 20.0 | 27.4 | .23*, .17 | ..... | ..... | Dull silky trace of granulation. |
| 3148 | 1,2 | .37 | .81 | 48,000 | 84,500 | 24.5 | 34.0 | .30*, .19 | ..... | ..... | Dull silky. |
| | | | | 40,500 | 77,500 | 25.5 | 34.0 | .29*, .22 | ..... | ..... | Do. |
| 3149 | 2,3 | .39 | .81 | 50,500 | 78,500 | 20.0 | 30.7 | .25*, .15 | 22.5 | 153 | Amorphous. |
| | | | | 43,500 | 80,500 | 23.5 | 27.4 | .25*, .22 | 22.0 | 153 | Do. |
| | | | | 50,500 | 87,500 | 18.5 | 24.0 | .19*, .18 | 23.5 | 163 | Amorphous trace of granulation. |
| 3150 | [1] 1,2,3 | .38 | .75 | 46,000 | 87,000 | 14.5 | 13.2 | .16*, .13 | ..... | ..... | Fine granular, 60 per cent; dull silky, 40 per cent. |
| | | | | 48,000 | 87,000 | 14.0 | 13.2 | .14*, .14 | ..... | ..... | Granular, 85 per cent; dull silky, 15 per cent. |
| | | | | 54,500 | 88,500 | 25.0 | 30.7 | .28*, .22 | ..... | ..... | Dull silky. |
| 3151 | 1,2 | .40 | .85 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3152 | 1,2 | .39 | .65 | 37,000 | 74,500 | 28.5 | 34.0 | .27*, .30* | ..... | ..... | Dull silky, 30 per cent; fine granular, 70 per cent. |
| | | | | 55,000 | 84,500 | 23.0 | 30.7 | .21, .25* | 23.0 | 163 | Amorphous. |
| 3153 | 1,2,3 | .41 | .65 | 51,000 | 90,500 | 18.0 | 24.0 | .18, .18* | ..... | ..... | Dull silky. |
| 3154 | 1,2 | .38 | .71 | 39,500 | 78,000 | 27.5 | 37.1 | .21, .34* | ..... | ..... | Do. |
| 3155 | 1,2 | .37 | .78 | 45,000 | 84 000 | 25.0 | 34.0 | .29*, .21 | ..... | ..... | Dull silky, trace of granulation. |
| 3156 | 2,3 | .39 | .94 | 51,000 | 90,000 | 19.0 | 24.0 | .22*, .16 | ..... | ..... | Dull silky. |
| 3157 | 2 | .38 | .78 | 34,500 | 72,500 | 31.0 | 40.3 | .39*, .23 | ..... | ..... | Do. |
| | | | | 44,000 | 84 500 | 24.0 | 30.7 | .20, .28* | 23.0 | ..... | Dull silky, trace of granulation. |
| 3158 | 2 | .37 | .75 | 34,000 | 63,000 | 34.5 | 49.1 | .28, .41* | ..... | ..... | Silky. |
| 3159 | 2,3 | .39 | .66 | 40,000 | 77,000 | 31.5 | 43.3 | .38*, .25 | ..... | ..... | Dull silky. |
| | | | | 45,000 | 87,500 | 22.0 | 30.7 | .26*, .18 | 25.0 | ..... | Dull silky, 90 per cent; granular, 10 per cent. |
| 3160 | 2 | .39 | .80 | 39,500 | 88,000 | 24.5 | 37.1 | .32*, .17 | ..... | ..... | Silky. |
| 3161 | 2 | .42 | .80 | 44,000 | 81,500 | 22.0 | 24.0 | .22*, .22 | ..... | ..... | Granular, 70 per cent; dull silky, 30 per cent. |
| 3162 | 2,3 | .44 | .78 | 64,500 | 101,500 | 20.5 | 30.7 | .27*, .14 | ..... | ..... | Dull silky, trace of granulation. |
| 3163 | 2 | .44 | .75 | 40,000 | 77,500 | 30.0 | 37.1 | .36*, .24 | ..... | ..... | Fine granular, amorphous spot at circumference. |
| 3164 | 2 | .38 | .74 | 39,000 | 74,500 | 28.0 | 37.1 | .22, .34* | ..... | ..... | Dull silky. |
| 3165 | 2 | .38 | .71 | 39,000 | 82,000 | 23.0 | 27.4 | .28*, .18 | ..... | ..... | Dull silky, 85 per cent; fine granular, 15 per cent. |
| 3166 | 2,3 | .36 | .74 | 47,000 | 83,500 | 25.0 | 34.0 | .25*, .25* | ..... | ..... | Do. |
| 3167 | 1,2 | .35 | .75 | 50,000 | 99,500 | 15.5 | 20.5 | .17*, .14 | ..... | ..... | Fine granular, 90 per cent; amorphous, 10 per cent. |
| | | | | 33,500 | 83,000 | 26.0 | 34.0 | .31*, .21 | 21.0 | ..... | Dull silky, trace of granulation. |
| 3168 | 2 | .37 | .80 | 50,500 | 88,500 | 22.5 | 34.0 | .20, .25* | ..... | ..... | Silky, trace of granulation. |
| 3169 | 2,3 | .38 | .74 | 55,000 | 88,500 | 22.5 | 27.4 | .23*, .22 | ..... | ..... | Dull silky. |
| 3170 | 1,2 | .40 | .72 | 41,000 | 77,000 | 27.5 | 40.3 | .25, .30* | ..... | ..... | Do. |
| 3171 | 1,2,3 | .39 | .77 | 50,500 | 84,500 | 25.0 | 40.3 | .17, .33* | 23.0 | ..... | Silky. |
| | | | | 41,000 | 77,500 | 24.5 | 37.1 | .19, .30* | ..... | ..... | Do. |
| 3172 | 2 | .38 | .72 | 49,500 | 89,500 | 21.5 | 30.7 | .17, .26* | ..... | ..... | Do. |
| 3173 | 1,2 | .38 | .67 | 44,000 | 80,500 | 27.0 | 37.1 | .21, .33* | ..... | ..... | Do. |
| 3174 | 2 | .48 | .67 | 51,500 | 93,500 | 18.5 | 20.5 | .16, .21* | ..... | ..... | Fine granular, 85 per cent; silky, 15 per cent. |
| 3175 | 2 | .42 | .76 | 47,500 | 81,500 | 22.5 | 27.4 | .20, .25* | ..... | ..... | Silky, trace of granulation. |
| 3176 | 2,3 | .42 | .72 | 49,000 | 89,500 | 8.0 | 9.5 | .06*, .08 | ..... | ..... | Fine granular, amorphous spot at circumference. |
| | | | | 48,500 | 91,000 | 20.0 | 27.4 | .18, .22* | 24.0 | ..... | Dull silky, 30 per cent; granular 70 per cent. |
| 3177 | [1] 1,2 | .36 | .77 | 45,500 | 82,000 | 20.5 | 27.4 | .23*, .18 | ..... | ..... | Silky. |
| 3178 | 2 | .38 | .80 | 39,000 | 73,000 | 27.5 | 40.3 | .34*, .21 | ..... | ..... | Silky. |
| | | | | 43,500 | 81,500 | 23.5 | 30.7 | .17, .30* | 24.0 | ..... | Dull-silky, trace of granulation. |
| 3179 | 1,2 | .37 | .79 | 34,500 | 72,500 | 30.0 | 37.1 | .32*, .28 | ..... | ..... | Silky. |
| | | | | 43,500 | 76,500 | 22.0 | 27.4 | .19, .25* | 20.0 | ..... | Dull silky. |
| 3180 | 1,2 | .37 | .77 | 39,000 | 68,500 | 29.5 | 40.3 | .30*, .29* | 20.0 | 137 | Do. |

[1] Navy.

*Cast steel from Watertown Arsenal steel plant*—Continued.

| Heat No. | Grade. | Chemical composition. | | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon. | Manganese. | | | | | | Shore. | Brinell. | |
| | | *Per cent.* | *Per cent.* | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* | | | |
| 3181 | 3 | 0.38 | 0.76 | 54,000 | 87,000 | 23.0 | 30.7 | 0.22, 0.24* | ..... | ..... | Silky. |
| | | | | 55,000 | 84,500 | 24.5 | 30.7 | .22, .27* | ..... | ..... | Do. |
| 3182 | 3 | .36 | .72 | 45,500 | 83,500 | 19.0 | 20.5 | .23*, .15 | ..... | ..... | Dull silky. |
| | | | | 55,500 | 89,500 | 22.0 | 30.7 | .17, .27* | ..... | ..... | Do. |
| 3183 | 1,2 | .36 | .78 | 35,500 | 71,500 | 28.5 | 37.1 | .33*, .24 | ..... | ..... | Silky. |
| | | | | 44,500 | 79,500 | 21.5 | 30.7 | .18, .25* | 23.0 | ..... | Dull silky, trace of granulation. |
| 3184 | 3 | .42 | .75 | 41,000 | 81,500 | 24.0 | 30.7 | .18, .30* | ..... | ..... | Silky granular spots. |
| | | | | 55,500 | 95,000 | 23.5 | 43.3 | .19, .28* | 27.5 | ..... | Silky. |
| 3185 | 1,2 | .39 | .76 | 34,500 | 71,000 | 27.5 | 37.1 | .22, .33* | ..... | ..... | Amorphous. |
| | | | | 48,500 | 80,000 | 26.5 | 34.0 | .33*, .20 | ..... | ..... | Dull silky. |
| 3186 | 1 | .39 | .72 | 44,200 | 79,400 | 24.0 | 27.4 | .20, .28* | ..... | ..... | Fine granular, 40 per cent; amorphous, 60 per cent. |
| 3187 | 1,2 | .36 | .74 | 45,500 | 86,000 | 18.5 | 16.9 | .21*, .16 | ..... | ..... | Amorphous, 60 per cent; granular, 40 per cent. |
| | | | | 58,000 | 96,000 | 22.5 | 37.1 | .23*, .22 | ..... | ..... | Dull silky. |
| 3188 | 1,2 | .37 | .75 | 43,000 | 80,000 | 24.0 | 34.0 | .29*, .19 | ..... | ..... | Silky, granular spots. |
| 3189 | ..... | .41 | .76 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3190 | 1 | .40 | .78 | 41,000 | 76 000 | 23.0 | 30.7 | .18, .28* | ..... | ..... | Silky. |
| 3191 | 1 | .40 | .75 | 44 000 | 80,000 | 25.0 | 30.7 | .19, .31 | ..... | ..... | Do. |
| 3192 | 1,2 | .42 | .74 | 37,000 | 75,000 | 29.0 | 37.1 | .29*, .29* | 22.0 | ..... | Do. |
| 3193 | 1,2 | .39 | .71 | 43,500 | 81,500 | 22.5 | 34.0 | .28*, .17 | ..... | ..... | Do. |
| 3194 | 1,2 | .46 | .72 | 44,000 | 83,500 | 24.5 | 30.7 | .26*, .23 | 22.5 | ..... | Do. |
| 3195 | 2,3 | .45 | .74 | 42,000 | 81,000 | 24.0 | 34.0 | .26*, .22 | ..... | ..... | Do. |
| | | | | 50,500 | 82,500 | 23.0 | 30.7 | .18, .28* | 21.0 | 146 | Amorphous. |
| 3196 | 3 | .42 | .77 | 43,500 | 79,900 | 25.0 | 30.7 | .25*, .25* | ..... | ..... | Dull silky, trace of granulation. |
| | | | | 40,500 | 74,500 | 26.5 | 37.2 | .30*, .23 | 21.0 | ..... | Silky. |
| | | | | 50,500 | 92,500 | 15.0 | 16.9 | .15*, .15 | 25.0 | ..... | Fine gr anular, 60 per cent; amorphous, 40 per cent. |
| 3197 | 1,2 | .37 | .79 | 48,500 | 87,000 | 24.0 | 34.0 | .31*, .17 | 25.0 | ..... | Silky. |
| 3198 | 2 | .35 | .91 | 44,000 | 82,000 | 25.0 | 37.1 | .22, .26* | ..... | ..... | Do. |
| 3199 | 1,2 | .41 | .90 | 48,500 | 91,500 | 22.5 | 30.7 | .27*, .18 | ..... | ..... | Do. |
| 3200 | 1 | .38 | .91 | 44,000 | 80,000 | 24.5 | 34.0 | .22, .27* | ..... | ..... | Do. |
| 3201 | 1 | .37 | .92 | 32,500 | 69,500 | 30.0 | 46.2 | .27, .33* | 21.0 | ..... | Dull silky. |
| 3202 | 2 | .35 | .80 | 58,500 | 96,000 | 22.5 | 34.0 | .24*, .21* | 23.0 | 174 | Do. |
| 3203 | 2,3 | .38 | .82 | 45,000 | 84,500 | 24.0 | 30.7 | .20, .28* | ..... | ..... | Silky. |
| 3204 | 1,2 | .40 | .84 | 44,500 | 82,000 | 24.5 | 27.4 | .19, .30* | ..... | ..... | Do. |
| 3205 | 3 | .35 | .92 | 48,500 | 89,500 | 20.5 | 24.0 | .22*, .19 | 25.0 | ..... | Silky, 40 per cent; granular, 60 per cent. |
| 3206 | 1 | .38 | .91 | 44,500 | 84,000 | 24.0 | 27.4 | .20, .28* | ..... | ..... | Silky. |
| 3207 | 1 | .38 | .78 | 41,700 | 76,700 | 27.0 | 37.1 | .34*, .20 | ..... | ..... | Do. |
| 3208 | 2,1 | .36 | .60 | 40,000 | 76,500 | 25.5 | 34.0 | .29*, .22 | 20.0 | 146 | Dull silky, trace of granulation. |
| 3209 | 2,3 | .38 | .75 | 46,000 | 86,000 | 24.5 | 37.1 | .25*, .24* | 25.0 | ..... | Silky, trace of granulation. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3210 | 1,2 | .37 | .80 | 46,000 | 84 500 | 24.5 | 34.0 | .19, .30* | 23.0 | ..... | Silky. |
| 3211 | 2,3 | .37 | .78 | 45,500 | 82,500 | 26.0 | 40.3 | .29*, .23 | 23.0 | ..... | Dull silky. |
| | | | | 56,000 | 94,500 | 19.0 | 24.0 | .23*, .15 | 27.0 | ..... | Silky. |
| 3212 | 2 | .35 | .75 | 44,000 | 78,500 | 24.0 | 34.0 | .20, .28* | 21.0 | 146 | Dull silky. |
| 3213 | 1,2 | .35 | .85 | 43,500 | 78,500 | 26.0 | 37.1 | .21, .31* | 21.0 | ..... | Silky. |
| 3214 | 1,2 | .36 | .80 | 41,500 | 79,000 | 26.0 | 37.1 | .23, .29* | 22.0 | ..... | Do. |
| 3215 | 1 | .34 | .87 | 38,500 | 77,500 | 27.5 | 43.3 | .35*, .20 | 23.0 | ..... | Silky, trace of granulation |
| 3216 | 1,2 | .36 | .78 | 48,500 | 94,500 | 20.5 | 27.4 | .20*, .21* | 24.0 | ..... | Silky, granular spots. |
| 3217 | 1,2 | .35 | .69 | 41,500 | 78,000 | 27.5 | 37.1 | .28*, .27* | 22.5 | ..... | Dull silky. |
| 3218 | 2 | .37 | .70 | 41,500 | 76,500 | 25.0 | 40.3 | .20, .30* | 24.0 | ..... | Do. |
| 3219 | 2 | .38 | .84 | 40,000 | 74,500 | 27.0 | 40.3 | .25, .29* | 21.0 | ..... | Silky. |
| 3220 | 2 | .36 | .93 | 34,500 | 71,000 | 28.5 | 40.3 | .38*, .19 | 21.0 | ..... | Do. |
| | | | | 50,500 | 84.500 | 23.5 | 30.7 | .25*, .22 | 20.5 | 163 | Dull silky. |
| 3221 | 1,2 | .34 | .80 | 43,500 | 81,000 | 26.0 | 37.1 | .19, .33* | 22.5 | ..... | Do. |
| 3222 | 1,2 | .35 | .71 | 42,000 | 78,500 | 25.5 | 40.3 | .32,* .19 | 23.0 | ..... | Do. |
| 3223 | 1 | .32 | .71 | 42,500 | 77,200 | 27.5 | 43.3 | .23, .32* | ..... | ..... | Dull silky, trace of granulation. |
| | | | | 44,500 | 83,500 | 25.0 | 30.7 | .27*, .23 | 22.0 | ..... | Dull silky, 40 per cent; fine granular, 60 per cent. |
| 3224 | 1 | .31 | .70 | 44,300 | 82,400 | 23.0 | 34.0 | .15, .31* | ..... | ..... | Dull silky, 80 per cent; fine granular, 20 per cent. |
| 3225 | 2,3 | .34 | .71 | 46,500 | 85,000 | 24.5 | 37.1 | .17, .32* | 22.0 | ..... | Silky. |
| 3226 | 1,2 | .31 | .92 | 39,000 | 75,500 | 28.5 | 37.1 | .33*, .24 | 21.0 | ..... | Dull silky. |
| 3227 | 1 | .30 | .75 | 37,000 | 72,000 | 28.5 | 43.3 | .38*, .19 | ..... | ..... | Dull silky, trace of granulation. |
| 3228 | 1,2,3 | .33 | .78 | 37,500 | 76,500 | 25.5 | 34.0 | .26*, .25* | 21.5 | ..... | Silky, 80 per cent; granular, 20 per cent. |
| 3229 | 1 | .35 | .81 | 36,500 | 76,500 | 25.0 | 37.1 | .32*, .18 | 22.5 | ..... | Silky, granular spots. |
| 3230 | 1,2 | .35 | ..... | 34,500 | 72,500 | 27.5 | 40.3 | .26, .29* | 22.0 | ..... | Silky. |
| 3231 | 2,3 | .33 | .87 | 43,500 | 94,500 | 12.0 | 13.2 | .11, .23* | 28.0 | ..... | Granular, silvery luster. |
| | | | | 56,000 | 91,500 | 24.0 | 37.1 | .29*, .19 | 24.5 | ..... | Dull silky. |
| | | | | 52,000 | 96,000 | 21.5 | 20.5 | .21*, .22* | 26.0 | ..... | Silky, 50 per cent; granular, 50 per cent. |
| 3232 | 2 | .32 | .93 | 38,100 | 79,200 | 24.0 | 30.7 | .15, .33* | ..... | ..... | Fine granular 70 per cent, amorphous 30 per cent. |
| 3233 | 1,2 | .33 | .97 | 32,500 | 69,000 | 25.5 | 37.1 | .30*, .21 | 22.0 | ..... | Silky. |
| | | | | 41,500 | 82,000 | 24.5 | 37.2 | .16, .33* | 21.5 | ..... | Dull silky. |
| 3234 | 1 | .32 | .90 | 37,500 | 77,500 | 26.0 | 34.0 | .22, .30* | 23.0 | ..... | Fine granular 60 per cent, dull silky 40 per cent. |
| 3235 | 1 | .32 | 1.00 | 42,000 | 84,500 | 19.5 | 27.4 | .16, .23* | 25.0 | ..... | Dull silky 35 per cent, coarse granular 65 per cent. |
| 3236 | 1,2 | .35 | .96 | 56,000 | 106,000 | 6.5 | 9.5 | .06, .07* | 32.0 | ..... | Granular. |
| | | | | 43,000 | 75,500 | 24.5 | 30.7 | .25*, .24 | 21.0 | ..... | Dull silky trace of granulation. |
| 3237 | 2 | .33 | ..... | 38,500 | 80,000 | 24.5 | 34.0 | .21, .28* | 25.0 | ..... | Dull silky granular spots. |
| 3238 | 1,2 | .35 | .82 | 35,500 | 75,000 | 27.0 | 37.1 | .32*, .22 | 22.0 | ..... | Do. |
| 3239 | 1,2 | .34 | .92 | 36,000 | 70,500 | 26.5 | 34.0 | .20, .33* | 22.0 | ..... | Silky. |
| | | | | 40,500 | 78,500 | 24.5 | 34.0 | .30*, .19 | 22.0 | ..... | Silky lamellar. |
| 3240 | 1 | .32 | .94 | 42,300 | 79,600 | 24.5 | 34.0 | .32*, .17 | ..... | ..... | Dull silky. |
| 3241 | 1 | .34 | .83 | 49,800 | 74,800 | 28.5 | 40.3 | .32*, .25 | ..... | ..... | Do. |
| 3242 | 1,2 | .32 | .79 | 45,400 | 90,500 | 20.5 | 24.0 | .18, .23* | ..... | ..... | Fine granular. |
| 3243 | 2 | .32 | .87 | 36,000 | 75,000 | 25.5 | 34.0 | .31*, .20 | 20.0 | ..... | Silky trace of granulation. |
| 3244 | 1,2 | .31 | .92 | 39,000 | 78,200 | 25.5 | 27.4 | .29*, .22 | ..... | ..... | Fine granular 60 per cent, amorphous 40 per cent. |
| 3245 | 2,3 | .35 | .95 | 38,500 | 80,000 | 24.5 | 30.7 | .21, .28* | 24.0 | ..... | Fine granular amorphous spot at circumference. |
| | | | | 48,000 | 81,500 | 26.0 | 30.7 | .23, .29* | 21.5 | 149 | Amorphous. |
| 3246 | 1,2 | .34 | .96 | 34,800 | 71,100 | 27.0 | 37.1 | .17, .37* | ..... | ..... | Dull silky trace of granulation |
| | | | | 37,500 | 77,000 | 24.0 | 30.7 | .30*, .18 | 20.5 | ..... | Fine granular 50 per cent, dull silky 50 per cent. |
| 3247 | 1,2 | .30 | .77 | 34,500 | 71,500 | 27.5 | 40.3 | .23, .32* | 21.0 | ..... | Silky granular spots. |
| | | | | 45,500 | 78,500 | 24.5 | 37.2 | .32*, .17 | 21.0 | 146 | Silky. |
| 3248 | 2 | .32 | .76 | 31,300 | 68,000 | 31.0 | 40.3 | .35*, .27 | ..... | ..... | Dull silky. |
| | | | | 38,500 | 75,000 | 26.0 | 37.2 | .26*, .26* | 21.5 | ..... | Do. |
| 3249 | 1,2 | .31 | .78 | 39,500 | 74,500 | 26.0 | 34.0 | .20, .32* | 23.0 | ..... | Do. |

*Cast steel from Watertown Arsenal steel plant*—Continued.

| Heat No. | Grade. | Chemical composition. | | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon. | Manganese. | | | | | | Shore. | Brinell. | |
| | | *Per cent.* | *Per cent.* | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* | | | |
| 3250 | 1,2 | 0.32 | 0.78 | 38,500 | 76,500. | 25.0 | 30.7 | 0.26*,0.24* | 22.0 | ..... | Silky. |
| 3251 | 1,2,3 | .34 | .81 | 38,500 | 77,000 | 26.0 | 30.7 | .22, .30* | 23.0 | ..... | Do. |
| | | | | 31,500 | 68,000 | 29.5 | 37.1 | .32*, .27* | 22.0 | ..... | Do. |
| 3252 | 1,2 | .33 | .82 | 37,700 | 76,700 | 24.5 | 30.7 | .24, .25* | ..... | ..... | Fine granular 70 per cent, amorphous 30 per cent. |
| | | | | 39,300 | 76,400 | 24.0 | 24.0 | .25*, .23 | ..... | ..... | Fine granular 75 per cent, amorphous 25 per cent. |
| 3253 | 1,2 | .33 | .84 | 38,400 | 76,600 | 26.0 | 37.1 | .33*, .19 | ..... | ..... | Dull silky trace of granulation. |
| 3254 | 2 | .30 | .80 | 49,700 | 71,400 | 27.0 | 37.1 | .32*, .22 | ..... | ..... | Dull silky. |
| | | | | 37,500 | 79,000 | 23.5 | 27.4 | .20, .27* | 21.0 | ..... | Fine granular 80 per cent, smooth spot at circumference 20 per cent. |
| 3255 | 2 | .32 | .83 | 40,900 | 73,100 | 27.0 | 37.1 | .24, .30* | ..... | ..... | Dull silky. |
| | | | | 46,500 | 77,000 | 26.0 | 40.3 | .34*, .18 | 22.0 | ..... | Silky. |
| 3256 | 2 | .32 | .79 | 41,100 | 75,000 | 29.0 | 37.1 | .22, .36* | ..... | ..... | Dull silky. |
| | | | | 50,500 | 95,000 | 21.0 | 27.4 | .18, .24* | 26.0 | ..... | Amorphous trace of granulation. |
| 3257 | 2,3 | .33 | .84 | 40,100 | 73,700 | 26.0 | 30.7 | .28*, .24 | ..... | ..... | Dull silky 50 per cent, fine granular 50 per cent. |
| | | | | 45,500 | 86,000 | 23.5 | 34.0 | .21, .26* | 24.0 | ..... | Dull silky. |
| | | | | 50,500 | 88,200 | 16.0 | 16.9 | .15, .17 | ..... | ..... | Dull silky 30 per cent, fine granular 70 per cent. |
| 3258 | 1,2 | .34 | .85 | 43,500 | 78,500 | 25.0 | 43.3 | .23, .27* | 21.0 | ..... | Dull silky. |
| | | | | 33,900 | 63,400 | 28.5 | 40.3 | .35*, .22 | ..... | ..... | Do. |
| 3259 | 1,2 | .32 | .83 | 43,000 | 78,500 | 27.0 | 37.2 | .30*, .24* | 23.0 | ..... | Do. |
| 3260 | 2 | ..... | ..... | 41,500 | 74,500 | 26.5 | 40.3 | .25*, .28* | 20.0 | ..... | Do. |
| 3261 | 1,2 | ..... | ..... | 39,500 | 73,200 | 27.5 | 34.0 | .22, .33* | ..... | ..... | Do. |
| | | | | 39,500 | 77,500 | 22.0 | 24.0 | .25*, .19 | 23.0 | ..... | Silky 55 per cent, granular 45 per cent. |
| 3262 | 2 | ..... | .72 | 44,500 | 88,500 | 19.5 | 20.5 | .20*, .19 | 24.5 | ..... | Fine granular silky spot at circumference. |
| 3263 | 2 | .41 | .72 | 39,000 | 75,000 | 25.0 | 30.7 | .30*, .20 | 20.0 | ..... | Dull silky trace of granulation. |
| 3264 | ..... | .40 | .75 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3265 | 2 | .38 | .82 | 32,300 | 68,100 | 26.5 | 27.4 | .23, .30* | ..... | ..... | Fine granular 75 per cent, amorphous 25 per cent. |
| | | | | 35,500 | 75,000 | 26.5 | 37.1 | .19, .34* | 21.0 | ..... | Dull silky. |
| 3266 | 1,2 | .39 | .81 | 35,500 | 72,800 | 33.0 | 40.3 | .26, .40* | ..... | ..... | Dull silky trace of granulation. |
| | | | | 41,500 | 84,000 | 17.5 | 20.5 | .14, .21* | 23.0 | ..... | Granular. |
| | | | | 49,000 | 92,000 | 11.5 | 13.3 | .13*, .10 | 21.5 | ..... | Fine granular 75 per cent, amorphous 25 per cent. |
| 3267 | 2 | .37 | .83 | 43,000 | 80,500 | 25.0 | 34.0 | .20, .30* | 21.5 | ..... | Dull silky. |
| | | | | 38,500 | 80,500 | 19.5 | 24.0 | .17, .22* | 23.5 | ..... | Fine granular 70 per cent, dull silky 30 per cent. |
| 3268 | 2,3 | .38 | .85 | 36,500 | 73,500 | 28.0 | 37.2 | .33*, .18* | 19.5 | ..... | Dull silky. |
| | | | | 48,000 | 82,000 | 24.5 | 34.0 | .29*, .20 | 23.0 | ..... | Do. |
| 3269 | 2,3 | .38 | .80 | 40,500 | 75,000 | 27.0 | 34.0 | .27*, .27* | 20.0 | ..... | Do. |
| | | | | 46,000 | 79,500 | 22.5 | 27.4 | .26*, .19 | 22.0 | ..... | Do. |
| 3270 | 1,2 | .37 | ..... | 42,500 | 73,000 | 27.0 | 37.2 | .27*, .27* | 20.0 | ..... | Do. |
| | | | | 40,500 | 76,500 | 25.0 | 30.7 | .20, .30* | 21.0 | ..... | Dull silky trace of granulation. |
| 3271 | 1 | .38 | .84 | 42,500 | 76,000 | 24.5 | 34.0 | .21, .28* | 20.5 | ..... | Dull silky. |
| 3272 | 2 | .36 | ..... | 39,000 | 80,000 | 21.5 | 24.0 | .25*, .18 | 23.0 | ..... | Dull silky, 60 per cent; fine granular, 40 per cent. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3273 | 2,3 | .34 | .80 | 45,500 | 87,000 | 21.0 | 27.4 | .25*, .17 | 24.0 | ..... | Silky, 40 per cent; granular, 60 per cent. |
| | | | | 42,500 | 76,000 | 25.0 | 30.7 | .23, .27* | 21.0 | ..... | Dull silky. |
| 3274 | 1,3 | .46 | .84 | 43,500 | 83,000 | 10.0 | 16.9 | .12*, .08 | 22.5 | ..... | Dull silky trace of granulation. |
| | | | | 53,500 | 83,500 | 21.0 | 24.0 | .19, .23* | 22.5 | ..... | Dull silky. |
| 3275 | 2,3 | .40 | .83 | 45,000 | 81,000 | 23.0 | 34.0 | .18, .28* | 21.0 | ..... | Do. |
| 3276 | 2 | .42 | ..... | 40,500 | 75,000 | 25.5 | 34.0 | .25*, .26* | 21.0 | ..... | Do. |
| 3277 | 2 | .50 | .80 | 43,500 | 72,000 | 29.0 | 40.3 | .26, .32* | 20.0 | ..... | Do. |
| | | | | 36,000 | 74,000 | 26.0 | 30.7 | .29*, .23 | 20.5 | ..... | Do. |
| 3278 | 2 | .43 | .79 | 43,000 | 79,000 | 24.5 | 34.0 | .19, .30* | 22.0 | 149 | Silky. |
| 3279 | 2 | .42 | .79 | 43,000 | 80,000 | 24.5 | 30.7 | .23, .26* | 23.0 | 116 | Dull silky. |
| 3280 | 2 | .42 | .79 | | | | | | | | |
| 3281 | 1,2 | .48 | .79 | 39,500 | 75,000 | 26.0 | 34.0 | .25, .27* | 22.0 | 137 | Do. |
| 3282 | 2,3 | .41 | .80 | 44,500 | 67,000 | 9.0 | 13.3 | .12*, .06 | 21.0 | 149 | Amorphous, spongy spot at circumference. |
| 3283 | 2,3 | .41 | .80 | | | | | | | | |
| 3284 | 2,3 | .45 | .80 | 45,500 | 89,500 | 21.0 | 27.4 | .23*, .19 | 24.0 | 163 | Dull silky 50 per cent, fine granular 50 per cent. |
| 3285 | 3 | .49 | .91 | 47,000 | 87,000 | 21.0 | 27.4 | .18, .24* | 23.5 | 163 | Do. |
| 3286 | 2,3 | .46 | .85 | 43,000 | 82,000 | 25.0 | 37.2 | .20*, .21 | 22.0 | 143 | Silky. |
| | | | | 57,500 | 86,500 | 22.0 | 27.4 | .21, .23* | 25.0 | ..... | Amorphous. |
| | | | | 49,000 | 89,500 | 17.5 | 16.9 | .17*, .18* | 25.0 | 166 | Dull silky 60 per cent, granular 40 per cent. |
| 3287 | 2 | .47 | .87 | 51,500 | 91,000 | 17.0 | 16.9 | .17, .17* | 21.5 | 163 | Dull silky 60 per cent, fine granular 40 per cent. |
| 3288 | 2 | .47 | .87 | 55,000 | 85,500 | 20.0 | 27.4 | .23*, .17 | 21.0 | 159 | Amorphous. |
| 3289 | 1,2 | .48 | .82 | 50,500 | 92,000 | 19.5 | 24.0 | .22*, .17 | 25.0 | 170 | Dull silky 30 per cent, granular 70 per cent. |
| | | | | 52,500 | 92,500 | 20.0 | 27.4 | .17, .23* | 22.5 | 163 | Amorphous 50 per cent, fine granular 50 per cent. |
| 3290 | 2,3 | .46 | .84 | 55,500 | 95,500 | 14.0 | 9.5 | .14, .14 | 26.0 | 163 | Fine granular 90 per cent, dull silky 10 per cent. |
| 3291 | | | | 57,000 | 87,500 | 25.0 | 37.2 | .31*, .19 | 24.0 | 156 | Dull silky. |
| 3292 | 1,2,3 | .44 | .85 | 39,500 | 74,000 | 26.5 | 34.0 | .27*, .26* | 21.5 | 140 | Silky. |
| | | | | 54,500 | 82,500 | 23.5 | 30.7 | .29*, .19 | 23.0 | 156 | Dull silky. |
| 3293 | 1 | .43 | .71 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3294 | 2 | .42 | .77 | 40,500 | 75.500 | 26.0 | 40.3 | .29*, .23 | 20.5 | 131 | Do. |
| 3295 | 2 | .45 | .75 | 44,000 | 75,500 | 26.0 | 37.2 | .20, .32* | 20.5 | 143 | Do. |
| 3296 | | | | | | | | | | | |
| 3297 | 2 | .44 | .78 | 43,000 | 75,500 | 26.0 | 34.0 | .21, .31* | 20.5 | 143 | Do. |
| 3298 | 2,3 | .42 | .74 | 40,500 | 73,500 | 15.0 | 20.5 | .17*, .13 | 21.0 | 126 | Dull silky, sandy spot at circumference. |
| 3299 | | | | 53,500 | 85,000 | 17.0 | 24.0 | .19*, .15 | 23.0 | 170 | Amorphous. |
| 3300 | 2 | .45 | .75 | 45,500 | 84,500 | 20.0 | 20.5 | .20*, .20* | 22.0 | 163 | Amorphous, 70 per cent; granular, 30 per cent. |
| 3301 | 2 | .40 | .80 | 36,500 | 74,500 | 23.0 | 27.4 | .19, .27* | 21.0 | 140 | Dull silky. |
| 3302 | 2 | .38 | .78 | 45,000 | 78,000 | 25.0 | 30.7 | .23, .27* | 21.5 | 143 | Do. |
| 3303 | | | | | | | | | | | |
| 3304 | 2 | .43 | .75 | 45,500 | 81,500 | 22.5 | 30.7 | .17, .28* | 20.0 | 153 | Do. |
| 3305 | 2 | .42 | .71 | | | | | | | | |
| 3306 | 2 | .45 | .78 | 45,000 | 79,000 | 24.0 | 34.0 | .20, .28* | 22.0 | 153 | Amorphous. |
| 3307 | 2,3 | .42 | .73 | 43,500 | 78,500 | 23.0 | 30.7 | .25*, .21 | 21.5 | 140 | Dull silky. |
| | | | | 52,000 | 84,000 | 16.0 | 20.5 | .15, .17* | 24.0 | 156 | Amorphous. |
| 3308 | 2 | .40 | .81 | 45,500 | 81,000 | 23.0 | 30.7 | .25*, .21 | 23.0 | 146 | Dull silky. |
| 3309 | 2 | .46 | | | | | | | | | |
| 3310 | 1,2 | .42 | .76 | 42,500 | 75.500 | 25.5 | 40.3 | .31*, .20 | 21.0 | 137 | Do. |
| 3311 | | | | | | | | | | | |
| 3312 | 2,3 | .43 | .79 | 39,500 | 76,000 | 24.5 | 34.0 | .16, .15 | 22.0 | 149 | Silky. |
| 3313 | | | | 54,000 | 87,500 | 19.0 | 20.5 | .25*, .13 | 21.5 | 163 | Dull silky. |
| 3314 | 2 | .43 | .80 | 44,000 | 79,500 | 24.0 | 30.7 | .24*, .24* | 23.0 | 156 | Amorphous. |
| 3315 | 2 | .46 | .74 | 45,500 | 79,500 | 15.5 | 24.0 | .18*, .13 | 21.5 | 146 | Dull silky. |
| 3316 | 3 | .41 | .77 | 53,500 | 88,000 | 22.5 | 34.0 | .25*, .20 | 24.0 | 159 | Silky. |

*Cast steel from Watertown Arsenal steel plant*—Continued.

| Heat No. | Grade. | Chemical composition. | | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon. | Manganese. | | | | | | Shore. | Brinell. | |
| | | *Per cent.* | *Per cent.* | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* | | | |
| 3317 | 2 | .39 | .70 | 45,500 | 81,000 | 25.5 | 37.2 | .27*, .24 | 22.0 | 156 | Silky oblique. |
| 3318 | | | .75 | | | | | | | | |
| 3319 | 1,2 | .44 | .73 | 39,500 | 70,500 | 28.5 | 37.2 | .30*, .27* | 22.0 | 126 | Dull silky. |
| 3320 | 2 | .41 | .70 | 43,000 | 82,000 | 22.5 | 30.7 | .28*, .17 | 22.5 | 149 | Amorphous. |
| 3321 | | | | | | | | | | | |
| 3322 | 1,2 | .38 | .91 | 40,500 | 74,500 | 21.5 | 27.4 | .22*, .21 | 22.0 | 131 | Dull silky, trace of granulation. |
| 3323 | | | | 54,500 | 83,500 | 12.5 | 16.9 | .15*, .10 | 22.0 | 156 | Amorphous, trace of granulation. |
| 3324 | 2,3 | .42 | .85 | 49,500 | 84,500 | 22.5 | 30.7 | .28*, .17 | 23.0 | ..... | Amorphous. |
| 3325 | | | | 50,500 | 84,500 | 25.0 | 40.3 | .31*, .19 | 23.0 | 163 | Dull silky. |
| 3326 | 2,3 | .44 | .78 | 41,500 | 72,000 | 10.5 | 13.3 | .12*, .09 | 21.5 | 143 | Ganular. |
| | | | | 44,500 | 75,500 | 14.0 | 16.9 | .09, .19* | 22.0 | 131 | Amorphous, trace of granulation. |
| | | | | 47,500 | 88,500 | 20.5 | 27.4 | .17, .24* | 23.5 | 170 | Amorphous, 60 per cent; granular, 40 per cent. |
| 3327 | 2 | .43 | .88 | 36,500 | 66,000 | 32.0 | 46.2 | .39*, .25 | 21.0 | 121 | Silky. |
| | | | | 38,500 | 67,000 | 25.0 | 43.3 | .16, .34* | 20.0 | 126 | Do. |
| | | | | 57,500 | 88,000 | 19.0 | 24.0 | .21*, .17 | 25.0 | 170 | Amorphous. |
| 3328 | 3 | .39 | .74 | 44,000 | 83,000 | 26.0 | 40.3 | .22, .30* | 22.5 | 149 | Dull silky. |
| | | | | 50,500 | 81,000 | 23.0 | 30.7 | .23*, .23* | 21.0 | 153 | Amorphous. |
| 3329 | 2,3 | .41 | .70 | 45,500 | 80,000 | 25.0 | 34.0 | .20, .30* | 21.0 | 149 | Dull silky. |
| 3330 | 2,3 | .40 | .73 | | | | | | | | |
| 3331 | 2 | .39 | .75 | 43,000 | 77,500 | 25.0 | 30.7 | .24*, .26* | 21.5 | 143 | Do. |
| 3332 | 1,2,3 | .40 | .72 | 40,500 | 76,000 | 14.5 | 24.0 | .12, .17* | 22.0 | 137 | Dull silky, trace of granulation. |
| 3333 | | .42 | .88 | 50,000 | 94,500 | 14.5 | 20.5 | .12, .17* | 25.0 | 183 | Dull silky. |
| 3334 | 2,3 | .50 | .78 | 40,500 | 74,000 | 28.0 | 37.2 | .28*, .28* | 21.0 | 126 | Do. |
| | | | | 50,500 | 80,500 | 20.5 | 27.4 | .22*, .19 | 23.5 | 149 | Amorphous. |
| 3335 | 3 | .42 | .78 | 40,500 | 74,000 | 21.0 | 27.4 | .24*, .18 | 22.0 | 131 | Silky. |
| | | | | 48,000 | 76,500 | 9.5 | 16.9 | .08, .11* | 22.0 | 149 | Amorphous. |
| | | | | 49,000 | 96,000 | 14.5 | 16.9 | .13, .16* | 25.0 | 170 | Amorphous, 70 per cent; granular, 30 per cent. |
| 3336 | 2,3 | .40 | .76 | 43,500 | 78,500 | 26.5 | 30.7 | .23, .30* | 22.0 | 149 | Dull silky, trace of granulation. |
| 3337 | | .41 | .80 | 49,500 | 94,000 | 18.0 | 20.5 | .15, .21* | 24.0 | 170 | Amorphous, 50 per cent; granular, 50 per cent. |
| 3338 | 2,3 | .39 | .73 | 43,000 | 80,500 | 18.5 | 20.5 | .17, .20* | 22.0 | 149 | Fine granular, 70 per cent; dull silky, 30 per cent. |
| | | | | 56,000 | 89,500 | 18.5 | 16.9 | .17, .20* | 23.0 | 163 | Amorphous. |
| | | | | 55,000 | 83,000 | 22.0 | 24.0 | .24*, .20 | 22.0 | 149 | Silky. |
| 3339 | 1,2 | .43 | .76 | 42,000 | 79,500 | 24.5 | 30.7 | .23*, .26* | 23.0 | 143 | Silky trace of granulation. |
| 3340 | | .46 | .79 | | | | | | | | |
| 3341 | 2,3 | .39 | .78 | 41,500 | 78,000 | 20.5 | 27.4 | .23*, .18 | 23.0 | 137 | Do. |
| | | | | 54,500 | 86,000 | 19.0 | 20.5 | .18*, .20* | 23.0 | 163 | Amorphous. |
| 3342 | 3 | .38 | .81 | 37,500 | 69,000 | 30.0 | 43.3 | .21, .39* | 21.0 | 126 | Silky. |
| | | | | 45,500 | 75,500 | 26.5 | 37.2 | .30*, .23 | 21.0 | 143 | Amorphous. |
| | | | | 50,500 | 88,500 | 18.0 | 20.5 | .18*, .18 | 23.0 | 163 | Do. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3343 | 2,3 | .39 | .70 | 40,500 | 79,000 | 19.0 | 24.0 | .18, .20* | 23.0 | 143 | Do. |
| | | | | 51,000 | 90,000 | 21.5 | 27.4 | .25*, .18 | 24.0 | 163 | Do. |
| 3344 | 2,3 | .44 | .70 | 45,500 | 82,000 | 20.0 | 30.7 | .17, .23* | 23.0 | 143 | Amorphous, 50 per cent; granular, 50 per cent. |
| | | | | 45,500 | 80,500 | 21.0 | 24.0 | .25*, .17 | 22.0 | 149 | Amorphous. |
| | | | | 55,500 | 88,000 | 17.0 | 20.5 | .17, .17* | 24.5 | 166 | Do. |
| 3345 | 1,2,3 | .42 | .84 | 43,000 | 82,000 | 17.0 | 16.9 | .19*, .15 | 23.0 | 149 | Amorphous, trace of granulation. |
| 3346 | | | | 45,000 | 80,000 | 22.5 | 24.0 | .19, .26* | 22.0 | 149 | Amorphous, 50 per cent; granular, 50 per cent. |
| | | | | 52,500 | 92,500 | 16.0 | 20.5 | .20*, .12 | 25.0 | 163 | Amorphous, trace of granulation. |
| 3347 | 3 | .41 | .88 | 49,500 | 87,000 | 14.5 | 13.3 | .14, .15* | 23.0 | 163 | Dull silky, 40 per cent; fine granular, 60 per cent. |
| 3348 | 3 | .41 | .88 | | | | | | | | |
| 3349 | ..... | .42 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3350 | 2,3 | .45 | .80 | 45,000 | 85,000 | 22.5 | 24.0 | .20*, .25* | 23.5 | 163 | Amorphous, 85 per cent; granular, 15 per cent. |
| 3351 | 3 | .41 | .78 | 44,400 | 81,300 | 27.0 | 40.3 | .28*, .26* | 23.0 | 149 | Amorphous, trace of granulation. |
| | | | | 53,000 | 85,000 | 24.5 | 40.3 | .17, .32* | 22.0 | 163 | Amorphous. |
| 3352 | ..... | .40 | .80 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3353 | 2,3 | .39 | .76 | 42,500 | 82,000 | 19.5 | 24.0 | .15, .24* | 22.5 | 156 | Amorphous, trace of granulation. |
| | | | | 54,000 | 87,500 | 18.0 | 24.0 | .18*, .18 | 24.0 | 166 | Amorphous. |
| 3354 | 1,2 | .39 | .70 | 39,000 | 72,000 | 24.5 | 30.7 | .18, .31* | 22.0 | 134 | Dull silky, trace of granulation. |
| 3355 | | | | | | | | | | | |
| | | | | 35,500 | 75,500 | 24.0 | 27.4 | .23, .25* | 22.0 | 146 | Amorphous, 30 per cent; fine granular, 70 per cent. |
| | | | | 45,000 | 83,000 | 15.0 | 16.9 | .12, .18* | 23.0 | 163 | Amorphous. |
| 3356 | 2,3 | .40 | .72 | 45,000 | 77,000 | 26.5 | 34.0 | .31*, .22 | 22.0 | 137 | Silky. |
| | | | | 43,000 | 80,000 | 18.0 | 24.0 | .15 .21* | 21.0 | 149 | Amorphous. |
| 3357 | 2,3 | .37 | .74 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3358 | 2 | .36 | .80 | 49,000 | 80,500 | 17.0 | 20.5 | .14, .20* | 22.0 | 159 | Granular, 60 per cent; dull silky, 40 per cent. |
| | | | | 45,000 | 78,000 | 25.0 | 30.7 | .23, .27* | 23.0 | 143 | Amorphous. |
| 3359 | 2,3 | .37 | .90 | 51,000 | 80,500 | 23.0 | 27.4 | .21, .25* | 21.5 | 156 | Do. |
| | | | | 48,000 | 79,500 | 26.0 | 40.3 | .34*, .18 | 20.5 | 153 | Dull silky. |
| | | | | 42,500 | 82,000 | 16.5 | 20.5 | .15, .18* | 22.0 | 156 | Amorphous, 15 per cent; granular, 85 per cent. |
| 3360 | 3 | .34 | .85 | 58,500 | 90,000 | 18.0 | 24.0 | .20*, .16 | 28.5 | 170 | Amorphous, 80 per cent: granular, 20 per cent. |
| 3361 | 2,3 | .35 | .83 | 46,500 | 84,000 | 19.0 | 24.0 | .19, .19* | 22.5 | 163 | Granular, 30 per cent; dull silky, 70 per cent. |
| 3362 | 1,2,3 | .38 | .82 | 44,500 | 75,500 | 26.0 | 27.4 | .27,* .25* | 18.5 | 137 | Dull silky. |
| 3363 | 2 | .37 | .86 | 36,000 | 73,000 | 27.0 | 37.2 | .28,* .26* | 21.0 | 131 | Do. |
| | | | | 55,000 | 86,500 | 19.0 | 20.5 | .21,* .17 | 23.0 | 163 | Amorphous. |
| 3364 | 2,3 | .36 | .84 | 50,500 | 83,500 | 15.5 | 20.5 | .14, .17* | 23.5 | 153 | Do. |
| 3365 | 2,3 | .40 | .80 | 44,500 | 81,500 | 22.0 | 27.4 | .22,* .22* | 23.0 | 156 | Amorphous trace of granulation. |
| | | | | 55,500 | 88,000 | 21.0 | 24.0 | .19, .23* | 24.5 | 153 | Amorphous, 85 per cent; granular, 15 per cent. |
| | | | | 31,500 | 66,500 | 27.0 | 37.2 | .20, .34* | 20.0 | 124 | Dull silky. |
| | | | | 32,500 | 67,000 | 25.0 | 34.0 | .30,* .20 | 19.5 | 124 | Amorphous. |
| 3366 | 2,3 | .38 | .82 | 45,000 | 74,500 | 19.5 | 24.0 | .22*, .17 | 20.5 | 137 | Do. |
| | | | | 45,500 | 72,000 | 25.5 | 30.7 | .27,* .24 | 20.0 | 126 | Do. |
| | | | | 36,000 | 69,500 | 26.5 | 37.2 | .26,* .29* | 20.0 | 134 | Dull silky. |
| | | | | 41,500 | 69,500 | 20.0 | 27.4 | .22,* .18 | 20.5 | 128 | Amorphous. |
| 3367 | 1 | .40 | .85 | 36,000 | 67,000 | 30.0 | 40.3 | .36,* .24 | 19.0 | 124 | Silky. |
| 3368 | | | | | | | | | | | |
| | | | | 36,000 | 77,000 | 22.5 | 27.4 | .29,* .16 | 23.0 | 143 | Amorphous, 60 per cent; granular, 40 per cent. |
| 3369 | 2,3 | .43 | .82 | 47,000 | 85,500 | 18.5 | 27.4 | .22,* .15 | 23.0 | 166 | Dull silky. |
| | | | | 49,500 | 81,500 | 15.0 | 16.9 | .14, .16* | 21.0 | 149 | Granular, 60 per cent; amorphous, 40 per cent. |
| | | | | 38,300 | 78,100 | 22.0 | 27.8 | .21, .23 | 22.0 | 143 | Amorphous trace of granulation. |
| | | | | 47,000 | 86,000 | 19.5 | 27.4 | .15, .24* | 23.0 | 170 | Amorphous. |
| 3370 | 2,3 | .42 | .80 | 42,500 | 79,500 | 21.5 | 27.4 | .23,* .20 | 21.0 | 149 | Dull silky trace of granulation. |
| | | | | 48,000 | 87,000 | 23.0 | 30.7 | .20, .26* | 22.0 | 156 | Amorphous trace of granulation. |

*Cast steel from Watertown Arsenal steel plant*—Continued.

| Heat No. | Grade. | Chemical composition. | | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon. | Manganese. | | | | | | Shore. | Brinell. | |
| | | *Per cent.* | *Per cent.* | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* | | | |
| 3371 | 3 | 0.41 | 0.78 | 42,500 | 79,000 | 17.5 | 24.0 | .15, .22* | 22.5 | 153 | Amorphous. |
| | | | | 51,500 | 83,500 | 17.0 | 24.0 | .19,* .15 | 22.5 | 159 | Do. |
| | | | | 45,500 | 79,500 | 14.5 | 16.9 | .16,* .13 | 21.0 | 156 | Do. |
| | | | | 54,000 | 83,500 | 13.0 | 16.9 | .11, .15* | 22.0 | 156 | Do. |
| 3372 | 1 | .41 | .78 | 38,000 | 77,000 | 22.0 | 27.4 | .25,* .19 | 21.0 | 143 | Amorphous trace of granulation. |
| 3373 | | .42 | .82 | | | | | | | | |
| 3374 | 2 | .42 | .85 | 48,500 | 76,500 | 6.0 | 5.7 | .06, .06 | 25.0 | 166 | Amorphous, 80 per cent; fine granular, 20 per cent. |
| | | | | 38,500 | 75,500 | 22.0 | 24.0 | .24,* .20 | 21.5 | 149 | Amorphous trace of granulation. |
| | | | | 35,000 | 72,000 | 22.5 | 27.4 | .27,* .18 | 21.0 | 137 | Dull silky. |
| 3375 | 3 | .43 | .83 | 47,000 | 78,000 | 23.5 | 30.7 | .22, .25* | 23.0 | 149 | Silky. |
| | | | | 44,000 | 74,500 | 23.5 | 30.7 | .19, .28* | 20.0 | 137 | Amorphous. |
| | | | | 46,000 | 79,000 | 23.0 | 27.4 | .20, .26* | 20.0 | 149 | Do. |
| | | | | 33,500 | 70,500 | 25.0 | 30.7 | .31,* .19 | 22.0 | 134 | Amorphous trace of granulation. |
| 3376 | 2,3 | .41 | .81 | 48,000 | 78,000 | 23.5 | 30.7 | .25,* .22 | 22.0 | 149 | Amorphous. |
| | | | | 36,000 | 73,000 | 22.5 | 27.4 | .18, .27* | 20.5 | 143 | Amorphous, 85 per cent; granular, 15 per cent. |
| | | | | 45,500 | 77,500 | 19.0 | 24.0 | .22,* .16 | 20.5 | 134 | Amorphous. |
| 3377 | 2 | .45 | .84 | 36,000 | 73,000 | 26.5 | 37.2 | .32,* .21 | 22.0 | 137 | Do. |
| 3378 | 2 | .43 | .83 | | | | | | | | |
| 3379 | 2,3 | .43 | .85 | 55,500 | 91,500 | 18.5 | 24.0 | .19,* .18* | 23.0 | 179 | Do. |
| 3380 | 2,3 | .41 | .85 | 55,000 | 84,000 | 23.5 | 37.2 | .26,* .21 | 21.0 | 163 | Do. |
| 3381 | 2,3 | .44 | .84 | 55,500 | 91,000 | 17.5 | 20.5 | .16, .19* | 22.5 | 179 | Do. |
| 3382 | 3 | .45 | .86 | 55,500 | 85,000 | 23.0 | 30.7 | .21, .25* | 21.5 | 163 | Do. |
| 3383 | 1 | .40 | .83 | 43,000 | 80,500 | 23.0 | 30.7 | .25,* .21 | 23.0 | 153 | Do. |
| 3384 | | .39 | .84 | | | | | | | | |
| 3385 | 2 | .42 | .84 | 50,000 | 90,500 | 15.5 | 16.9 | .15, .16* | 23.0 | 170 | Amorphous, 50 per cent; fine granular, 50 per cent. |
| | | | | 49,000 | 84,500 | 22.5 | 30.7 | .21, .24* | 22.5 | 163 | Amorphous trace of granulation. |
| 3386 | 2,3 | .40 | .86 | 53,500 | 91,000 | 21.0 | 30.7 | .25,* .17 | 22.0 | 174 | Dull silky. |
| 3387 | 3 | .44 | .84 | 54,500 | 86,500 | 22.5 | 30.7 | .17, .28* | 23.0 | 163 | Amorphous. |
| 3388 | 2,3 | .45 | .83 | 47,500 | 81,500 | 23.0 | 30.7 | .19, .27* | 22.0 | 149 | Do. |
| 3389 | 2,3 | .43 | .85 | 48,500 | 91,000 | 20.0 | 27.4 | .16, .24 | 23.0 | 179 | Silky oblique. |
| 3390 | 2,3 | .42 | .82 | 52,500 | 87,500 | 22.5 | 30.7 | .25,* .20 | 23.0 | 170 | Amorphous. |
| 3391 | 2,3 | .42 | .85 | 51,000 | 89,500 | 19.0 | 27.4 | .16, .22* | 23.0 | 166 | Do. |
| 3392 | 2 | .41 | .84 | 44,000 | 79,000 | 23.5 | 24.0 | .28,* .19 | 20.0 | 149 | Do. |
| 3393 | 2 | .42 | .86 | 45,500 | 81,500 | 20.0 | 24.0 | .20,* .20* | 22.0 | 159 | Do. |
| 3394 | 1,2 | .40 | .83 | 48,000 | 81,000 | 24.0 | 34.0 | .29,* .19 | 22.0 | 153 | Do. |
| 3395 | 2 | .40 | .82 | 40,500 | 77,500 | 28.0 | 43.3 | .36,* .20 | 22.0 | 146 | Silky. |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 54,500 | 93,500 | 13.5 | 16.9 | .15,* .12 | 25.0 | 174 | Amorphous, 80 per cent; granular, 20 per cent. |
| | | | | 56,500 | 90,500 | 14.0 | 16.9 | .13, .15* | 22.0 | 166 | Amorphous, 70 per cent; granular, 30 per cent. |
| 3396 | 2,3 | .44 | .81 | 57,000 | 88,000 | 10.5 | 16.9 | .10, .11* | 22.5 | 170 | Amorphous, 50 per cent; fine granular, 50 per cent. |
| | | | | 57,000 | 87,000 | 9.5 | 16.9 | .11,* .08 | 22.5 | 170 | Amorphous. |
| | | | | 50,000 | 82,500 | 12.0 | 13.3 | .11, .13* | 22.0 | 149 | Dull silky, 30 per cent; granular, 70 per cent. |
| | | | | 70,000 | 122,000 | 4.5 | 5.7 | .05, .04 | 32.5 | 255 | Fine granular; silky spot at circumference. |
| 3397 | 2,3 | .43 | .85 | 47,500 | 101,500 | 8.0 | 9.5 | .08, .08* | 27.0 | 207 | Granular. |
| | | | | 66,000 | 119,500 | 5.0 | 5.7 | .06,* .04 | 34.0 | 249 | Fine granular. |
| | | | | 45,000 | 97,500 | 8.5 | 9.5 | .07,* .10* | 26.0 | 192 | Fine granular; amorphous spot at circumference. |
| 3398 | 3 | .45 | .83 | 55,500 | 86,500 | 19.0 | 20.5 | .21,* .17 | 23.0 | 163 | Amorphous. |
| 3399 | 3 | .44 | .84 | 50,500 | 88,000 | 21.0 | 30.7 | .25,* .17 | 21.0 | 170 | Do. |
| | | | | 60,500 | 116,500 | 5.0 | 5.7 | .04, .06* | 31.0 | 241 | Fine granular; amorphous spot at circumference. |
| 3400 | 2 | ..... | ..... | 47,500 | 101,000 | 7.5 | 5.7 | .09,* .06 | 28.5 | 202 | Fine granular; silky spot at circumference. |
| | | | | 64,000 | 118,000 | 5.5 | 5.7 | .07,* .04 | 32.0 | 241 | Fine granular, with amorphous spot at circumference. |
| 3401 | 2,3 | ..... | ..... | 45,500 | 81,500 | 24.0 | 37.2 | .19, .29* | 20.0 | 149 | Silky. |
| 3402 | 2 | ..... | ..... | 48,000 | 81,000 | 26.0 | 37.2 | .23, .29* | 21.0 | 156 | Amorphous. |
| 3403 | 2 | ..... | ..... | 45,000 | 82,000 | 24.0 | 27.4 | .23 .25* | 22.0 | 153 | Amorphous trace of granulation. |
| 3404 | 2,3 | .40 | .85 | 40,500 | 74,000 | 25.0 | 43.3 | .35,* .15 | 18.0 | 137 | Silky. |
| | | | | 45,500 | 79,500 | 26.0 | 40.3 | .30,* .22 | 20.0 | 156 | Dull silky. |
| 3405 | 2 | .38 | .86 | 49,000 | 85,000 | 20.5 | 24.0 | .21,* .20 | 23.0 | 163 | Amorphous. |
| 3406 | 2 | .39 | .83 | 44,500 | 84,000 | 24.0 | 30.7 | .22, .26* | 22.0 | 156 | Do. |
| 3407 | 2,3 | .38 | .84 | 53,500 | 94,500 | 17.0 | 20.5 | .17, .17* | 25.5 | 179 | Fine granular, 70 per cent; amorphous, 30 per cent. |
| 3408 | 2,3 | .41 | .81 | 64,000 | 101,500 | 13.5 | 16.9 | .14,* .13* | 26.0 | 192 | Do. |
| | | | | 48,000 | 88,500 | 18.5 | 20.5 | .18, .19* | 25.0 | 163 | Fine granular; silky spot at circumference. |
| 3409 | ..... | .40 | .85 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3410 | 3 | .41 | .86 | 50,000 | 85,000 | 22.5 | 27.4 | .23,* .22* | 22.5 | 163 | Amorphous trace of granulation. |
| | | | | 40,500 | 74,000 | 27.0 | 40.3 | .25, .29* | 21.0 | 137 | Dull silky. |
| 3411 | 2,3 | .40 | .82 | 44,500 | 75,500 | 24.0 | 27.4 | .20, .28* | 20.5 | 137 | Amorphous. |
| | | | | 45,000 | 79,000 | 23.5 | 30.7 | .21, .26* | 22.5 | 149 | Silky. |
| | | | | 58,500 | 83,500 | 6.5 | 5.7 | .06, .07* | 24.5 | 170 | Amorphous. |
| 3412 | 1,2 | .38 | .84 | 52,500 | 77,500 | 9.0 | 9.5 | .10,* .08 | 23.0 | 156 | Do. |
| | | | | 64,500 | 84,000 | 8.0 | 9.5 | .10,* .06 | 24.5 | 170 | Do. |
| | | | | 60,500 | 100,500 | 11.0 | 13.3 | .09, .13* | 26.0 | 196 | Fine granular, 70 per cent; amorphous, 30 per cent. |
| 3413 | 2,3 | .43 | .87 | 45,000 | 88,000 | 15.5 | 13.3 | .16,* .15* | 24.0 | 159 | Fine granular, 70 per cent; silky, 30 per cent. |
| 3414 | 2 | .41 | .81 | 49,000 | 87,500 | 21.0 | 24.0 | .19, .23* | 20.0 | 156 | Silky. |
| 3415 | 2 | .43 | .85 | 41,500 | 81,000 | 21.5 | 27.4 | .25,* .18 | 18.0 | 149 | Dull silky. |
| 3416 | 3 | .45 | .84 | 39,500 | 75,000 | 27.0 | 46.2 | .38,* .16 | 18.5 | 134 | Silky. |
| | | | | 50,500 | 94,500 | 19.0 | 27.4 | .22,* .16 | 22.5 | 183 | Amorphous. |
| 3417 | 3 | .42 | .84 | 49,500 | 87,500 | 22.5 | 30.7 | .19, .26* | 19.0 | 156 | Dull silky. |
| 3418 | ..... | .40 | .82 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3419 | 2 | .41 | .83 | 44,500 | 78,000 | 26.5 | 37.2 | .32,* .21 | 20.0 | 143 | Do. |
| 3420 | ..... | .43 | .81 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3421 | 2,3 | .43 | .85 | 65,500 | 103,000 | 16.5 | 20.5 | .17,* .16* | 26.0 | 192 | Fine granular 85 per cent, amorphous 15 per cent. |
| 3422 | 2,3 | .42 | .87 | 55,000 | 94,000 | 22.0 | 30.7 | .25,* .19 | 24.0 | 174 | Amorphous. |
| 3423 | 2 | .38 | .82 | 45,500 | 81,500 | 31.0 | 43.3 | .25, .37* | 20.0 | 149 | Dull silky. |
| 3424 | 3 | .42 | .84 | 44,500 | 80,500 | 24.5 | 30.7 | .25,* .24* | 20.0 | 146 | Do. |
| 3425 | 2 | .32 | .82 | 50,500 | 88,000 | 23.5 | 30.7 | .26,* .21 | 20.5 | 170 | Do. |
| 3426 | 3 | .39 | .85 | 42,500 | 79,500 | 24.0 | 30.7 | .28,* .20 | 20.0 | 149 | Do. |
| | | | | 48,500 | 85,000 | 21.0 | 27.4 | .24,* .18 | 21.0 | 163 | Amorphous trace of granulation. |
| 3427 | 3 | .40 | .81 | 45,000 | 80,500 | 22.5 | 30.7 | .21, .24* | 21.0 | 158 | Dull silky. |
| 3428 | ..... | .38 | .86 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3429 | 2 | .37 | .83 | 45,000 | 81,000 | 31.0 | 40.3 | .32,* .30 | 20.0 | 146 | Do. |

*Cast steel from Watertown Arsenal steel plant*—Continued.

| Heat No. | Grade. | Chemical composition. | | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon. | Manganese. | | | | | | Shore. | Brinell. | |
| | | *Per cent.* | *Per cent.* | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* | | | |
| 3430 | 2,3 | 0.43 | 0.87 | 56,500 | 85,000 | 8.0 | 9.5 | 0.07, 0.09* | 24.0 | 170 | Amorphous trace of granulation. |
| | | | | 50,500 | 79,000 | 10.5 | 9.5 | .10, .11* | 24.0 | 149 | Amorphous. |
| | | | | 59,500 | 80,500 | 6.0 | 5.7 | .07,* .05 | 24.0 | 170 | Do. |
| | | | | 52,000 | 74,500 | 8.5 | 9.5 | .07, .10* | 22.0 | 143 | Do. |
| 3431 | 3 | .34 | .83 | 45,500 | 85,500 | 23.5 | 27.4 | .25,* .22 | 22.0 | 163 | Amorphous trace of granulation. |
| 3432 | 3 | 1.25 | .85 | | | | | | | | |
| 3433 | 2 | .39 | .85 | 45,500 | 79,000 | 26.5 | 37.2 | .31,* .22 | 19.0 | 146 | Dull silky. |
| 3434 | | .41 | .86 | | | | | | | | |
| 3435 | 2 | .41 | .84 | 47,500 | 80,500 | 25.0 | 34.0 | .30,* .20 | 21.0 | 143 | Do. |
| 3436 | 3 | .44 | .82 | 54,000 | 92,500 | 22.5 | 34.0 | .28,* .17 | 23.0 | 174 | Do. |
| 3437 | 3 | .39 | .85 | 55,500 | 85,000 | 9.5 | 13.3 | .10,* .09 | 23.0 | 159 | Amorphous trace of granulation. |
| | | | | 50,500 | 80,000 | 14.0 | 13.3 | .16,* .12 | 23.0 | 153 | Amorphous. |
| | | | | 59,500 | 85,000 | 11.0 | 13.3 | .13,* .09 | 23.0 | 170 | Do. |
| | | | | 50,500 | 76,000 | 13.5 | 13.3 | .15,* .12 | 22.0 | 149 | Do. |
| 3438 | 2 | .44 | .83 | 57,500 | 88,000 | 9.5 | 9.5 | .08, .11* | 23.5 | 170 | Amorphous trace of granulation. |
| | | | | 50,000 | 80,500 | 12.5 | 13.3 | .12,* .13* | 24.0 | 149 | Do. |
| | | | | 60,000 | 86,000 | 9.0 | 9.5 | .08, .10* | 24.0 | 179 | Amorphous. |
| | | | | 51,500 | 77,000 | 11.0 | 13.3 | .13,* .09 | 22.0 | 146 | Do. |
| 3439 | 2,3 | .45 | .82 | 57,500 | 85,500 | 7.5 | 9.5 | .09,* .06 | 24.0 | 166 | Amorphous trace of granulation. |
| | | | | 51,000 | 80,000 | 10.5 | 9.5 | .10,* .11* | 23.5 | 149 | Do. |
| | | | | 57,500 | 84,000 | 8.0 | 9.5 | .09,* .07 | 24.0 | 179 | Amorphous. |
| | | | | 52,500 | 77,500 | 12.0 | 13.3 | .14,* .10 | 22.5 | 149 | Amorphous trace of granulation. |
| 3440 | | .40 | .84 | | | | | | | | |
| 3441 | | .42 | .82 | | | | | | | | |
| 3442 | 3 | .46 | .93 | 59,000 | 85,500 | 8.5 | 5.7 | .07, .10* | 23.5 | 170 | Do. |
| | | | | 50,500 | 75,500 | 11.0 | 13.3 | .13,* .09 | 22.0 | 143 | Do. |
| 3443 | | .38 | .85 | | | | | | | | |
| 3444 | 3 | .44 | .86 | 57,000 | 86,500 | 8.5 | 9.5 | .07, .10* | 23.0 | 170 | Amorphous 50 per cent, granular 50 per cent. |
| | | | | 49,500 | 77,500 | 12.0 | 13.3 | .14,* .10 | 23.0 | 149 | Amorphous 70 per cent, fine granular 30 per cent. |
| 3445 | 3 | .46 | .83 | 52,500 | 91,000 | 17.0 | 20.5 | .16, .18* | 21.0 | 166 | Amorphous 75 per cent, granular 25 per cent. |
| 3446 | 2,3 | .44 | .82 | 50,500 | 87,500 | 18.0 | 20.5 | .17, .19* | 22.0 | 166 | Amorphous trace of granulation. |
| 3447 | 2,3 | .45 | .83 | 49,000 | 84,500 | 22.5 | 27.4 | .24,* .21* | 22.0 | 159 | Dull silky. |
| 3448 | 3 | .44 | .85 | 42,500 | 78,500 | 23.5 | 34.0 | .24,* .23* | 20.0 | 137 | Do. |
| | | | | 45,500 | 77,500 | 26.0 | 30.7 | .24, .23* | 21.0 | 137 | Do. |
| | | | | 53,500 | 80,500 | 19.5 | 27.4 | .15, .24* | 22.0 | 156 | Do. |
| 3449 | | .46 | .86 | | | | | | | | |
| 3450 | | .46 | .86 | | | | | | | | |
| 3451 | 3 | .44 | .86 | 45,000 | 87,000 | 22.0 | 34.0 | .20, .24* | 23.0 | 170 | Do. |
| 3452 | 3 | .43 | .90 | 44,500 | 84,500 | 20.0 | 27.4 | .19, .21* | 21.0 | 158 | Dull silky trace of granulation. |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3453 | 2,3 | .44 | 1.00 | 45,500 | 85,000 | 25.5 | 34.0 | .30,* .21 | 21.0 | 156 | Dull silky. |
| 3454 | ..... | .43 | .81 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3455 | ..... | .41 | .86 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3456 | ..... | .38 | .91 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3457 | ..... | .41 | .90 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3458 | 3 | .43 | .85 | 40,500 | 78,000 | 23.5 | 30.7 | .22,* .25* | 21.5 | 146 | Do. |
| | | | | 50,500 | 86,500 | 19.0 | 24.0 | .18, .20* | 23.0 | 163 | Do. |
| 3459 | ..... | .42 | .83 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3460 | 3 | .38 | .79 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3461 | ..... | .39 | .82 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3462 | ..... | .43 | .83 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3463 | 2,3 | .45 | .85 | 42,500 | 80,000 | 21.0 | 24.0 | .20, .22* | 22.0 | 149 | Dull silky 50 per cent, fine granular 50 per cent. |
| | | | | 55,000 | 88,500 | 20.5 | 24.0 | .22,* .19* | 23.0 | 174 | Dull silky. |
| 3464 | 1 | .30 | .78 | 39,500 | 72,000 | 28.0 | 37.2 | .29,* .27 | 21.0 | 134 | Silky. |
| 3465 | ..... | .35 | .86 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3466 | 2,3 | .43 | .84 | 47,000 | 84,500 | 24.0 | 30.7 | .21, .27* | 22.5 | 159 | Dull silky. |
| 3467 | ..... | .38 | .82 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3468 | ..... | .37 | .84 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3469 | 3 | ..... | ..... | 48,000 | 82,000 | 23.5 | 34.0 | .24,* .23* | 23.5 | 149 | Do. |
| 3470 | | | | | | | | | | | |
| 3471 | 1,3 | .43 | .83 | 55,500 | 88,500 | 11.5 | 13.3 | .10*, .13* | 24.5 | 166 | Fine granular 50 per cent, amorphous 50 per cent. |
| | | | | 48,500 | 79,000 | 15.5 | 16.9 | .17,* .14 | 22.0 | 143 | Amorphous 50 per cent, fine granular 50 per cent. |
| 3473 | 3 | .45 | .85 | 49,000 | 89,500 | 18.0 | 24.0 | .18,* .18* | 23.0 | 170 | Amorphous. |
| 3474 | ..... | .38 | .87 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | |
| 3477 | 1 | .47 | .95 | 49,000 | 80,500 | 26.5 | 37.2 | .24, .29* | 22.0 | 156 | Do. |
| 3478 | 3 | .37 | 1.05 | 60,500 | 88,000 | 8.0 | 9.5 | .06,* .08* | 25.0 | 179 | Amorphous 70 per cent, fine granular 30 per cent. |
| | | | | 50,500 | 79,000 | 11.5 | 13.3 | .11, .12* | 22.2 | 149 | Amorphous. |
| 3479 | 3 | .46 | 1.19 | 60,500 | 89,500 | 8.5 | 9.5 | .10,* .07 | 24.0 | 179 | Amorphous 70 per cent, fine granular 30 per cent. |
| | | | | 49,500 | 79,500 | 13.0 | 16.9 | .12, .14* | 23.0 | 156 | Amorphous 50 per cent, granular 50 per cent. |

## CAST STEEL FROM OPEN-HEARTH FURNACE AT WATERTOWN ARSENAL FOUNDRY.

| Heat No. | Grade. | Chemical composition. | | | | | Elastic limit (pounds per square inch). | Tensile strength (pounds per square inch). | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon. | Manganese. | Silicon. | Sulphur. | Phosphorus. | | | | | | Shore. | Brinell. | |
| | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *Lb.* | *Lb.* | *P. ct.* | *P. ct.* | *In.* *In.* | | | |
| 1 O. H.. | ..... | 0.32 | 0.70 | 0.344 | 0.038 | 0.044 | 46,300 | 83,800 | 20.0 | 20.5 | 0.18, 0.22* | 23.0 | ..... | Granular, 80 per cent; dull silky, 20 per cent. |
| 2 O. H.. | 2,3 | .41 | .71 | .280 | .032 | .035 | 39,000 | 80,500 | 17.0 | 16.9 | .18*, .16 | 22.0 | ..... | Fine granular; silky spot at circumference. |
| | | | | | | | 34,500 | 81,000 | 25.5 | 30.7 | .25, .26* | 23.0 | ..... | Silky, 30 per cent; granular, 70 per cent. |
| | | | | | | | 49,000 | 87,500 | 24.5 | 30.7 | .24, .25* | 23.0 | 163 | Silky. |
| 3 O. H.. | 1,2,3 | .38 | .70 | .283 | .035 | .040 | 38,500 | 81,000 | 18.5 | 20.5 | .16, .21* | 24.5 | ..... | Fine granular; silky spot at circumference. |
| | | | | | | | 36,500 | 71,500 | 32.2 | 46.2 | .35*, .26 | 21.0 | ..... | Silky. |
| | | | | | | | 38,500 | 81,500 | 6.5 | 9.5 | .05, .06* | 24.0 | ..... | Fine granular. |
| | | | | | | | 39,000 | 85,500 | 11.5 | 9.5 | .12*, .11 | 25.0 | ..... | Do. |
| 4 O. H.. | 2,3 | .50 | .70 | .280 | .036 | .040 | 38,000 | 85,000 | 18.0 | 16.9 | .15, .21* | 24.5 | ..... | Fine granular; silky spot at circumference. |
| | | | | | | | 46,500 | 87,500 | 9.5 | 13.3 | .09, .10* | 24.5 | 170 | Fine granular, 90 per cent; amorphous, 10 per cent. |
| | | | | | | | 55,000 | 85,500 | 17.0 | 24.0 | .17, .17 | 23.0 | 163 | Amorphous. |
| 5 O. H.. | 2,3 | .45 | .65 | .283 | .040 | .040 | 44,500 | 84,000 | 19.5 | 24.0 | .16, .23* | 23.0 | ..... | Fine granular, 50 per cent; dull silky, 50 per cent. |
| 6 O. H.. | 1,2,3 | .39 | .65 | .250 | .038 | .035 | 32,500 | 71,000 | 28.0 | 40.3 | .25, .31* | 19.5 | ..... | Dull silky. |
| | | | | | | | 44,000 | 78,000 | 24.0 | 30.7 | .20, .28 | 21.5 | 153 | Silky. |
| | | | | | | | 46,000 | 88,000 | 9.5 | 13.3 | .10*, .09 | 24.0 | 170 | Fine granular, 85 per cent; amorphous, 15 per cent. |
| | | | | | | | 52,500 | 83,000 | 24.0 | 34.0 | .22*, .26* | 21.0 | 159 | Dull silky. |
| 7 O. H.. | 1,2,3 | .38 | .68 | .262 | .040 | .038 | 35,000 | 71,500 | 23.0 | 30.7 | .20, .26* | 21.5 | ..... | Do. |
| | | | | | | | 48,000 | 80,500 | 16.0 | 24.0 | .13, .19* | 21.5 | 153 | Dull silky trace of granulation. |
| 8 O. H.. | 1,2,3 | .39 | .72 | .300 | .036 | .035 | 35,000 | 72,000 | 24.0 | 27.4 | .27*, .21 | 21.0 | ..... | Dull silky. |
| | | | | | | | 42,500 | 77,000 | 29.0 | 40.3 | .27, .31* | 22.0 | 146 | Silky. |
| | | | | | | | 47,000 | 90,000 | 10.5 | 13.3 | .12*, .09 | 23.5 | 174 | Fine granular, 80 per cent; amorphous, 20 per cent. |
| | | | | | | | 46,500 | 82,000 | 27.5 | 34.0 | .21, .34* | 21.0 | 156 | Silky. |
| 9 O. H.. | 2,3 | .41 | .70 | .285 | .030 | .040 | 39,000 | 79,500 | 22.0 | 27.4 | .26*, .18 | 23.0 | ..... | Dull silky trace of granulation. |
| | | | | | | | 43,000 | 88,500 | 18.0 | 27.4 | .10, .26* | 22.5 | 159 | Granular, smooth spot at circumference. |
| | | | | | | | 48,500 | 84,000 | 23.5 | 37.2 | .16, .31* | 22.0 | 159 | Silky. |
| | | | | | | | 49,500 | 90,500 | 11.5 | 16.9 | .10, .13* | 25.0 | 179 | Fine granular, 65 per cent; amorphous, 20 per cent. |
| | | | | | | | 57,000 | 85,000 | 21.0 | 27.4 | .18, .24* | 25.0 | 159 | Amorphous. |
| 10 O. H.. | 1,2,3 | .38 | .68 | ..... | .038 | .037 | 37,500 | 75,500 | 29.0 | 43.3 | .23, .35* | 21.0 | ..... | Dull silky. |
| | | | | | | | 50,000 | 84,000 | 16.5 | 24.0 | .15, .18* | 22.0 | 156 | Do. |
| 11 O. H.. | 2,3 | .38 | .69 | ..... | .039 | .039 | 37,500 | 76,500 | 24.0 | 30.7 | .27*, .21 | 22.0 | 143 | Silky. |
| | | | | | | | 50,000 | 82,500 | 23.5 | 30.7 | .27*, .20 | 21.0 | 149 | Amorphous. |
| 12 O. H.. Al Ti... | 1,2,3 | .40 | .68 | ..... | .038 | .038 | 39,000 | 82,000 | 23.5 | 34.0 | .29*, .18 | 22.0 | 156 | Silky, with granular spots near circumference. |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 O. H.. Al Ti... | 2,3 | .45 | .63 | ..... | ..... | ..... | 50,000 | 91,000 | 21.0 | 27.4 | .22*, .20 | 23.5 | 170 | Silky. |
| 14 O. H.. Al Ti... | 2,3 | .46 | .55 | ..... | .036 | .040 | 40,000 | 85,500 | 19.5 | 20.5 | .17, .22* | 23.0 | 159 | Do. |
| | | | | | | | 48,000 | 88,000 | 11.0 | 13.3 | .09, .13* | 24.0 | 170 | Fine granular, 50 per cent; amorphous, 5 per cent. |
| | | | | | | | 50,500 | 91,000 | 16.0 | 20.5 | .18*, .14 | 25.0 | 170 | Dull silky. |
| 15 O. H.. | 2,3 | .47 | .36 | | | | 39,500 | 82,500 | 19.5 | 24.0 | .17, .22* | 23.0 | 156 | Silky, 85 per cent; granular, 15 per cent. |
| | | | | | | | 51,500 | 88,000 | 19.5 | 20.5 | .19*, .19* | 22.5 | 166 | Dull silky, 65 per cent; granular, 35 per cent. |

* Inch section in which fracture occurred.

# STEEL FORGINGS FOR ORDNANCE WORK.

## *FORGED STEEL FROM WATERTOWN ARSENAL SMITH SHOP.*

[The inch in which fracture occurred is marked thus: *.]

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* *In.* | | | |
| 276F | D | 131,500 | 154,000 | 15.5 | 43.3 | 0.23*, 0.08 | 48.0 | ..... | Silky. |
| 454F | 3 | 37,500 | 76,500 | 17.5 | 43.3 | .09, .26* | 28.5 | ..... | Dull silky. |
| | | 43,000 | 86,500 | 25.0 | 40.3 | .19, .31* | 26.0 | ..... | Silky. |
| | | 61,000 | 99,000 | 22.5 | 51.9 | .35*, .10 | 33.0 | ..... | Do. |
| 476F | 3 | 43,000 | 99,500 | 19.5 | 34.0 | .27*, .12 | 32.0 | ..... | Dull silky, 30 per cent; granular, 70 per cent. |
| 517F | A | 79,000 | 122,000 | 20.0 | 49.1 | .10, .30* | 39.0 | ..... | Silky. |
| 519F [1] | ..... | 100,000 | 121,500 | 17.5 | 54.6 | .06, .29* | 37.0 | ..... | Fine silky. |
| 520F [1] | ..... | 67,000 | 113,000 | 21.5 | 49.1 | .12, .31* | 36.0 | ..... | Silky. |
| 521F | 3 | 49,500 | 93,000 | 11.0 | 16.9 | .09, .13* | 28.0 | ..... | Amorphous, 30 per cent; fine granular, 70 per cent. |
| | | 47,000 | 81,000 | 25.0 | 40.3 | .20, .30* | 24.0 | ..... | Silky. |
| | | 72,500 | 103,500 | 8.0 | 13.2 | .10*, .06 | 33.5 | ..... | Silky and lamellar. |
| | | 61,000 | 100,500 | 16.5 | 30.7 | .10, .23* | 29.0 | ..... | Silky. |
| 535F [1] | ..... | 104,000 | 165,000 | 13.0 | 43.3 | .05, .21* | 46.0 | ..... | Do. |
| 536F [1] | ..... | 60,000 | 118,500 | 18.5 | 37.1 | .27*, .10 | 35.0 | ..... | Silky; trace of granulation. |
| 537F | D | 97,500 | 155,500 | 14.0 | 40.3 | .23*, .05 | 41.0 | ..... | Silky, serrated. |
| 541F | 2 | 50,000 | 81,500 | 27.5 | 49.1 | .28*, .27* | 25.0 | ..... | Silky. |
| 762F | 3 | 58,230 | 91,330 | 27.0 | 49.3 | .36*, .18 | 27.0 | ..... | Fine silky. |
| | | 58,200 | 101,000 | 22.0 | 46.4 | .12, .32* | 28.0 | ..... | Do. |
| | | 106,000 | 109,000 | 15.5 | 54.6 | .12, .19* | 33.0 | ..... | Do. |
| 764F | C and 3 | 73,000 | 106,000 | 25.5 | 59.8 | .34*, .17 | 32.0 | ..... | Fine silky; cup shaped. |
| | | 77,000 | 106,000 | 26.5 | 62.2 | .38*, .15 | 33.0 | ..... | Fine silky. |
| | | 55,900 | 101,000 | 23.0 | 49.3 | .13, .33* | 29.0 | ..... | Do. |
| 765F | C and 3 | 74,000 | 102,000 | 26.0 | 64.6 | .40*, .12 | 38.0 | ..... | Do. |
| | | 77,000 | 106,000 | 26.0 | 57.2 | .26*, .26* | 34.0 | ..... | Fine silky; cup shaped. |
| 767F | C | 55,500 | 109,000 | 8.5 | 9.5 | .07, .10* | 35.0 | ..... | Fine granular. |
| 771F | C | 50,000 | 101,000 | 13.0 | 13.2 | .11, .15* | ..... | ..... | Coarse granular. |
| | | 146,000 | 155,000 | 15.0 | 43.3 | .24*, .06 | 47.0 | ..... | Fine silky. |
| 785F | 2 | 56,000 | 107,000 | 18.5 | 34.0 | .25*, .12 | 31.5 | ..... | Amorphous, trace of granulation. |
| | | 62,000 | 110,000 | 21.5 | 34.0 | .23*, .20 | 32.0 | ..... | Do. |
| 787F | 3 | 60,000 | 90,000 | 27.5 | 64.6 | .42*, .13 | 34.0 | ..... | Fine silky. |
| 815F | 3 | 45,500 | 94,000 | 20.5 | 34.0 | .28*, .13 | 32.0 | ..... | Amorphous. |
| 826F | 3 | 45,000 | 76,500 | 28.0 | 43.3 | .38*, .18 | 26.0 | ..... | Silky. |
| | | 66,500 | 102,500 | 18.5 | 34.0 | .18, .19* | 30.5 | ..... | Fine granular, 50 per cent; amorphous, 50 per cent. |
| 829F | 3 | 49,500 | 85,000 | 28.0 | 51.9 | .23, .33* | 27.0 | ..... | Silky. |
| | | 62,000 | 102,000 | 19.0 | 49.1 | .08, .30* | 31.0 | ..... | Dull silky. |
| 830F | 3 | 50,000 | 90,500 | 28.0 | 43.3 | .36*, .20 | 29.0 | ..... | Silky. |
| 832F | 2 | 50,500 | 78,500 | 31.0 | 59.8 | .44*, .18 | 26.0 | ..... | Fine silky. |
| 844F | 3 | 52,000 | 93,000 | 23.0 | 30.5 | .23*, .23* | 29.0 | ..... | Silky; trace of granulation. |
| 847F | 3 | 44,000 | 81,000 | 27.0 | 51.9 | .40*, .14 | 25.0 | ..... | Dull silky. |
| | | 49,000 | 85,000 | 28.0 | 54.6 | .17, .39* | ..... | ..... | Fine silky. |
| | | 50,000 | 87,000 | 29.0 | 54.6 | .19, .39* | ..... | ..... | Do. |
| | | [2] 61,500 | ..... | ..... | ..... | ..... | ..... | ..... | |
| | | 67,000 | 104,500 | 21.0 | 51.9 | .30*, .12* | 30.0 | ..... | Do. |
| 850F | 3 | 47,000 | 104,500 | 13.5 | 13.2 | .14*, .13 | ..... | ..... | Fine granular with amorphous spot at circumference. |
| | | 46,000 | 100,500 | 17.5 | 20.5 | .20*, .15 | ..... | ..... | Do. |
| | | 46,000 | 91,000 | 22.5 | 43.3 | .12, .33* | ..... | ..... | Dull silky. |
| 853F | 2 | 51,000 | 85,500 | 27.5 | 43.3 | .21, .34 | 27.0 | ..... | Do. |

[1] 60,000 lb. per sq. in. elastic limit required.
[2] Stripped threads on specimen at 20,600-lb. load.

*Forged steel from Watertown Arsenal smith shop*—Continued.

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In. In.* | | | |
| | | 63,000 | 105,000 | 26.0 | 51.9 | 0.22, 0.30* | ..... | ..... | Fine silky. |
| | | 72,500 | 111,000 | 25.0 | 57.2 | .33*, .17 | ..... | ..... | Do. |
| | | 72,000 | 111,500 | 25.0 | 54.6 | .36*, .14 | ..... | ..... | Do. |
| 865F | C..... | 75,000 | 108,500 | 25.5 | 59.8 | .38*, .13 | ..... | ..... | Fine silky, cup shaped. |
| | | 73,500 | 108,500 | 25.0 | 57.2 | .20, .30* | ..... | ..... | Do. |
| | | 98,000 | 124,000 | 17.0 | 49.1 | .07, .27* | ..... | ..... | Fine silky. |
| 866F | ..... | 94,000 | 119,500 | 16.5 | 51.9 | .27*, .06 | ..... | ..... | Do. |
| 867F | ..... | 98,000 | 124,500 | 17.0 | 49.1 | .27*, .07 | ..... | ..... | Fine silky, cup shaped. |
| 868F | ..... | 99,500 | 124,000 | 16.5 | 51.9 | .27*, .06 | ..... | ..... | Fine silky. |
| 877F | 3..... | 64,000 | 110,000 | 20.0 | 51.9 | .08, .32* | 28.0 | ..... | Do. |
| 879F | 3..... | 49,000 | 84,000 | 28.0 | 51.9 | .39*, .18 | ..... | ..... | Silky. |
| 883F | 3..... | 88,000 | 142,500 | 14.5 | 30.7 | .21*, .08 | ..... | ..... | Fine granular, silky spot in center. |
| | | 47,500 | 90,500 | 23.5 | 30.7 | .22*, .25* | ..... | ..... | Silky. |
| 885F [1] | ..... | 44,500 | 80,000 | 25.0 | 40.3 | .34*, .16 | 25.5 | ..... | Dull silky. |
| 886F | 3..... | 55,500 | 96,500 | 20.5 | 43.3 | .31*, .10 | ..... | ..... | Fine silky. |
| 890F | C..... | 67,000 | 116,500 | 23.0 | 57.2 | .34*, .12 | ..... | ..... | Do. |
| | | 83,000 | 123,000 | 17.5 | 43.3 | .25*, .10 | ..... | ..... | Silky; trace of granulation. |
| 891F | ..... | 87,000 | 124,000 | 17.0 | 40.3 | .10, .24* | ..... | ..... | Do. |
| 892F | ..... | 84,500 | 123,500 | 17.0 | 43.3 | .16, .18* | ..... | ..... | Do. |
| 902F | 3..... | 50,000 | 99,000 | 19.5 | 30.7 | .22*, .17 | ..... | ..... | Dull silky, granular spots. |
| 903F | C..... | 70,000 | 114,500 | 15.0 | 37.1 | .06, .24* | ..... | ..... | Dull silky. |
| | | 141,500 | 143,500 | 16.5 | 49.1 | .06, .27* | ..... | ..... | Fine silky, serrated. |
| 904F | C..... | 119,000 | 138,000 | 18.0 | 51.9 | .27*, .09 | ..... | ..... | Do. |
| 906F | 2..... | 55,000 | 96,500 | 25.5 | 40.3 | .33, .18 | ..... | ..... | Silky. |
| 913F | C..... | 119,000 | 138,000 | 18.5 | 51.9 | .29*, .08 | ..... | ..... | Silky, serrated. |
| 914F | ..... | 123,000 | 142,000 | 19.0 | 51.9 | .13, .25* | ..... | ..... | Do. |
| 919 F | 3..... | 46,500 | 60,500 | 32.5 | 66.9 | .18, .47* | ..... | ..... | Fine silky. |
| 921 F | 2..... | 59,500 | 88,500 | 26.5 | 46.2 | .29*, .24* | ..... | ..... | Do. |
| 927 F | D..... | 150,000 | 164,500 | 13.0 | 46.2 | .23*, .03 | ..... | ..... | Do. |
| | | 100,000 | 145,500 | 12.5 | 51.9 | .22*, .03 | ..... | ..... | Fine silky; cup shaped. |
| 928 F | D..... | 119,500 | 141,000 | 13.0 | 37.1 | .21*, .05 | ..... | ..... | Fine silky. |
| | | 47,500 | 99,500 | 20.0 | 37.1 | .10, .30* | ..... | ..... | Fine granular; silky spot at circumference. |
| 930 F | D..... | 65,000 | 114,000 | 21.0 | 46.2 | .16, .26* | ..... | ..... | Fine silky. |
| 931 F | No. 5 Navy | 70,500 | 109,500 | 16.5 | 37.1 | .09, .24* | ..... | ..... | Fine granular. |
| 932 F | ...do..... | 86,500 | 113,000 | 22.5 | 49.1 | .13, .32* | 33.0 | ..... | Fine silky. |
| 933 F | 3..... | 56,500 | 98,500 | 21.5 | 54.6 | .11, .32* | ..... | ..... | Do. |
| 935 AB | Nickel steel. | 53,000 | 95,000 | 23.5 | 46.2 | .34*, .13 | ..... | ..... | Silky. |
| 935 F | ...do..... | 79,000 | 111,000 | 20.0 | 57.2 | .32*, .08 | 32.0 | ..... | Fine silky; cup shaped. |
| 936 F | ...do..... | 88,000 | 118,000 | 21.0 | 57.2 | .09, .33* | 32.0 | ..... | Fine silky; serrated. |
| 936 BB | ...do..... | 51,000 | 92,500 | 24.5 | 51.9 | .13, .36* | ..... | ..... | Silky. |
| 936 BM | ...do..... | 57,500 | 95,000 | 24.5 | 51.9 | .12, .37* | ..... | ..... | Do. |
| 937 F | ...do..... | 93,000 | 124,500 | 17.5 | 51.9 | .05, .30* | 31.0 | ..... | Fine silky. |
| | | 81,000 | 120,500 | 18.5 | 46.2 | .22,* .15 | 33.0 | ..... | Do. |
| 937 CB | ...do..... | 55,500 | 99,000 | 19.0 | 30.7 | .14, .24* | ..... | ..... | Fine granular; amorphous spot at circumference. |
| 937 CM | ...do..... | 59,000 | 91,000 | 25.5 | 57.2 | .15, .36* | ..... | ..... | Fine silky. |
| 938 F | ...do..... | 86,500 | 117,000 | 20.5 | 57.2 | .09, .32* | 36.0 | ..... | Fine silky; serrated. |
| 938 DB | ...do..... | 51,000 | 94,500 | 19.0 | 46.2 | .10, .28* | ..... | ..... | Silky. |
| 938 DM | ...do..... | 57,500 | 92,500 | 25.0 | 54.6 | .14, .36* | ..... | ..... | Do. |
| 939 F | ...do..... | 96,000 | 127,000 | 18.0 | 54.6 | .29*, .07 | 35.0 | ..... | Fine silky. |
| 939 EB | ...do..... | 50,500 | 89,500 | 24.5 | 49.1 | .14, .35* | ..... | ..... | Do. |
| 939 EM | ...do..... | 57,500 | 100,000 | 22.0 | 49.1 | .11, .33* | ..... | ..... | Do. |
| 940 F | 3..... | 60,000 | 98,500 | 18.0 | 40.3 | .28*, .08 | ..... | ..... | Fine silky, with small open seam at center. |
| 942 F | Nickel steel. | 54,000 | 99,500 | 23.0 | 46.2 | .32*, .14 | ..... | ..... | Silky. |
| | | 58,500 | 99,000 | 24.0 | 51.9 | .36*, .12 | ..... | ..... | Do. |
| | | 86,000 | 113,500 | 20.0 | 59.8 | .33*, .07 | 31.0 | ..... | Fine silky; cup shaped. |

[1] 60,000 lb. per sq. in. elastic limit required.

*Forged steel from Watertown Arsenal smith shop*—Continued.

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* *In.* | | | |
| 943 F | Nickel steel. | 57,000 | 102,500 | 19.0 | 37.1 | 0.11, 0.27* | ..... | ..... | Dull silky; trace of granulation. |
| | | 64,500 | 98,000 | 25.0 | 51.9 | .14, .36* | ..... | ..... | Silky. |
| | | 62,000 | 95,000 | 15.0 | 57.2 | .29*, .01 | 23.0 | ..... | Fine silky. |
| | | 72,500 | 104,500 | 23.5 | 59.8 | .24*, .23* | 31.0 | ..... | Do. |
| 944 F | ...do..... | 57,000 | 100,500 | 23.0 | 43.3 | .18, .28* | ..... | ..... | Dull silky. |
| | | 65,000 | 96,500 | 26.0 | 51.9 | .37*, .15 | ..... | ..... | Fine silky. |
| | | 85,500 | 115,500 | 20.5 | 57.2 | .14, .27* | 33.0 | ..... | Do. |
| 945 F | ...do..... | 51,500 | 93,000 | 22.0 | 49.1 | .11, .33 | ..... | ..... | Dull silky. |
| | | 64,000 | 95,500 | 26.0 | 54.6 | 14, .38* | ..... | ..... | Fine silky. |
| | | 83,500 | 112,500 | 21.5 | 59.8 | .34*, .09 | 31.0 | ..... | Do. |
| 946 F | ...do..... | 57,500 | 102,000 | 22.0 | 43.3 | .13, .31* | ..... | ..... | Dull silky; trace of granulation. |
| | | 56,500 | 99,000 | 23.0 | 46.2 | .14, .32* | ..... | ..... | Silky. |
| | | 77,000 | 106,000 | 21.0 | 62.2 | .35*, .07 | 30.0 | ..... | Fine silky; cup shaped. |
| 947 F | 3..... | 64,000 | 105,000 | 21.5 | 37.1 | .13, .30* | ..... | ..... | Fine granular. |
| 953 F | 3..... | 43,000 | 87,500 | 24.0 | 43.3 | .35*, .13 | ..... | ..... | Silky. |
| | | 42,500 | 91,500 | 21.0 | 37.1 | .12, .30* | ..... | ..... | Dull silky; trace of granulation. |
| 954 F | 2..... | 49,000 | 101,500 | 18.0 | 24.0 | .18*, .18* | ..... | ..... | Medium fine granular. |
| | | 58,000 | 106,000 | 18.0 | 46.2 | .08, .28* | ..... | ..... | Fine silky. |
| | | 62,500 | 98,000 | 24.5 | 54.6 | .36*, .13 | ..... | ..... | Do. |
| 966 F | 1..... | 41,000 | 61,500 | 35.5 | 66.9 | .51*, .20 | ..... | ..... | Do. |
| 982 F | 3..... | 62,500 | 95,000 | 26.0 | 57.2 | .14 .38* | ..... | ..... | Do. |
| 986 F | 2..... | 58,000 | 127,000 | 12.5 | 16.9 | .10, .15* | ..... | ..... | Fine granular. |
| | | 64,000 | 97,500 | 24.5 | 51.9 | .12, .37* | ..... | ..... | Fine silky. |
| 1003 | 2..... | 58,500 | 124,500 | 10.5 | 16.9 | .13*, .08 | 37.0 | ..... | Fine granular. |
| 1006 | 2..... | 56,000 | 100,000 | 21.5 | 37.1 | .22*, .21* | ..... | ..... | Silky; trace of granulation. |
| 1010 F | 1..... | 37,000 | 61,000 | 36.5 | 64.7 | .40*, .33* | ..... | ..... | Fine silky. |
| 1018 F | 3..... | 54,000 | 83,500 | 27.5 | 57.2 | .15, .40* | ..... | ..... | Do. |
| | | 77,000 | 108,000 | 22.0 | 54.6 | .13, .31* | 32.0 | ..... | Do. |
| 1034 F | D..... | 65,500 | 93,500 | 26.5 | 54.6 | .16, .37* | ..... | ..... | Do. |
| | | 145,500 | 160,000 | 14.0 | 51.9 | .03, .24* | 48.0 | ..... | Fine silky; cup shaped. |
| 1038 F [1] | ..... | 58,500 | 86,000 | 26.0 | 46.2 | .25*, .27* | 25.0 | ..... | Fine silky. |
| | | 99,000 | 126,000 | 19.5 | 54.6 | .23*, .16 | 39.0 | ..... | Silky; serrated. |
| 1039 F | A..... | 122,000 | 140,500 | 19.0 | 59.6 | .08, .30* | 36.0 | ..... | Fine silky; serrated |
| 1040 F | 3..... | 48,000 | 80,500 | 29.0 | 54.6 | .42*, .16 | ..... | ..... | Fine silky. |
| | | 56,500 | 95,000 | 25.5 | 49.1 | .29*, .22 | 28.0 | ..... | Do. |
| 1046 F | 3..... | 58,500 | 94,500 | 25.0 | 46.2 | .33*, .17 | ..... | ..... | Do. |
| 1047 F | 3..... | 46,500 | 77,500 | 30.0 | 51.9 | .36*, .24 | ..... | ..... | Do. |
| 1051 F | Nickel steel No. 2 Navy. | 65,000 | 92,500 | 27.0 | 51.9 | ..... | ..... | ..... | Silky; cup shaped. |
| | | 65,000 | 92,500 | 28.0 | 54.6 | .22, .34* | 23.5 | ..... | Fine silky. |
| 1052 F | ...do..... | 53,800 | 92,200 | 26.5 | 51.9 | .36*, .17 | 25.0 | ..... | Do. |
| | | 98,000 | 124,500 | 18.0 | 49.1 | .28*, .08 | 33.0 | 241 | Silky, serrated. |
| | | 93,000 | 121,000 | 20.5 | 59.8 | .30*, .11 | 36.0 | 235 | Fine silky; serrated. |
| | | 93,500 | 121,000 | 20.5 | 59.8 | .15, .26* | 34.0 | 241 | Fine silky; cup shaped. |
| 1053 F | ...do..... | 65,000 | 97,500 | 27.5 | 59.8 | .17, .38* | 24.0 | ..... | Fine silky. |
| 1054 F | ...do..... | 56,000 | 91,500 | 28.0 | 57.2 | .22, .34* | 24.0 | ..... | Fine silky; cup shaped. |
| | | 96,000 | 132,000 | 15.5 | 43.3 | .05, .26* | 35.0 | 262 | Fine silky. |
| | | 89,500 | 119,500 | 20.5 | 54.6 | .32*, .09 | 31.0 | 235 | Fine silky; serrated. |
| 1055 F | ...do..... | 62,500 | 91,000 | 29.0 | 54.6 | .40*, .18 | 24.0 | ..... | Fine silky. |
| 1056 F | ...do..... | 64,500 | 99,000 | 25.0 | 57.2 | .13, .37* | 25.0 | ..... | Do. |
| | | 58,500 | 97,500 | 24.5 | 57.2 | .37*, .12 | 26.0 | ..... | Do. |
| 1057 F | ...do..... | 100,000 | 122,000 | 17.5 | 51.9 | .06, .29* | 33.0 | 241 | Silky; serrated. |
| | | 90,000 | 116,500 | 22.0 | 59.8 | .17, .27* | 34.0 | 241 | Fine silky; serrated. |
| | | 92,000 | 118,500 | 21.5 | 59.8 | .30*, .13 | 33.0 | 241 | Do. |
| 1058 F | ...do..... | 56,000 | 90,500 | 28.0 | 57.2 | .16, .40* | 24.0 | ..... | Fine silky. |
| | | 113,000 | 132,000 | 18.5 | 49.1 | .17, .20* | 35.0 | 255 | Silky, serrated. |
| | | 93,500 | 123,500 | 19.5 | 51.9 | .29,* .10 | 36.0 | 248 | Fine silky; serrated |
| | | 91,500 | 121,500 | 19.5 | 54.6 | .32,* .07 | 34.0 | 255 | Do. |
| 1059 F | ...do..... | 51,500 | 90,500 | 27.5 | 51.9 | .20, .35* | 27.0 | ..... | Fine silky. |
| | | 51,000 | 91,000 | 21.0 | 54.6 | .14, .38* | ..... | ..... | Silky. |
| | | 95,000 | 128,500 | 17.0 | 49.1 | .28*, .06 | 36.0 | 255 | Fine silky. |
| | | 92,000 | 122,000 | 19.0 | 54.6 | .09, .29* | 34.0 | 241 | Fine silky; serrated. |

[1] 60,000 lbs. per sq. in. elastic limit required.

*Forged steel from Watertown Arsenal smith shop*—Continued.

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In. In.* | | | |
| 1060 F | Nickel steel No. 2 Navy. | 62,000 | 101,500 | 26.5 | 54.6 | 0.33*, 0.20 | 26.0 | ..... | Fine silky. |
| 1061 F | ...do..... | 63,000 | 99,500 | 26.5 | 57.2 | .14, .39* | 25.0 | ..... | Do. |
| 1062 F | ...do..... | 68,500 | 97,500 | 28.0 | 59.8 | .25, .31* | 26.0 | ..... | Do. |
| 1063 F | ...do..... | 65,000 | 105,000 | 22.5 | 51.9 | .11, .34* | 28.0 | ..... | Do. |
| 1064 F | ...do..... | 57,500 | 93,500 | 28.5 | 59.8 | .18, .39* | 29.0 | ..... | Do. |
| | | 100,000 | 121,500 | 19.5 | 57.2 | .07, .32* | 33.5 | 241 | Silky; serrated. |
| | | 94,000 | 120,500 | 21.5 | 59.8 | .23*, .20* | 34.0 | 248 | Fine silky; serrated. |
| | | 91,500 | 120,000 | 22.0 | 57.2 | .20*, .24* | 32.0 | 248 | Do. |
| 1065 F | ...do..... | 49,000 | 90,500 | 27.5 | 51.9 | .34*, .21 | ..... | ..... | Fine silky. |
| 1067 F | ...do..... | 59,000 | 100,000 | 22.0 | 34.0 | .24*, .20* | 27.0 | 183 | Silky. |
| | | 58,000 | 101,500 | 21.0 | 34.0 | .21*, .21* | 27.0 | 192 | Silky; trace of granulation. |
| 1068 F | ...do..... | 55,500 | 93,000 | 25.5 | 43.3 | .28*, .23* | 23.5 | 170 | Fine silky; cup shaped. |
| 1071 F | ...do..... | 60,500 | 93,000 | 23.5 | 34.0 | .23*, .24* | 23.0 | 170 | Fine silky. |
| 1074 F | ...do..... | 83,000 | 116,500 | 19.0 | 51.9 | .31*, .07 | 34.0 | 255 | Fine silky; serrated. |
| 1080 F | ...do..... | 55,000 | 95,000 | 24.5 | 43.3 | .25*, .24* | 24.0 | 179 | Fine silky. |
| | | 83,500 | 119,000 | 18.5 | 46.2 | .12, .25* | 24.0 | ..... | Silky; cup shaped. |
| 1081 F | ...do..... | 66,500 | 94,500 | 27.5 | 54.6 | .34*, .21 | 28.0 | ..... | Fine silky; cup shaped. |
| 1082 F | ...do..... | 66,000 | 93,500 | 27.0 | 51.9 | .35*, .19 | 25.0 | ..... | Fine silky. |
| 1083 F | ..... | 64,500 | 113,500 | 20.0 | 40.3 | .14, .26* | 31.0 | ..... | Do. |
| 1086 F | C..... | 66,500 | 116,000 | 17.0 | 40.3 | .08, .26* | 31.0 | ..... | Silky. |
| | | 122,500 | 147,000 | 16.0 | 46.2 | .23,* .09 | 40.0 | ..... | Fine silky. |
| 1099 F | Nickel steel No. 2 Navy. | 57,000 | 96,500 | 23.0 | 40.3 | .16, .30* | 28.0 | 183 | Silky. |
| 1103 F | ...do..... | 58,500 | 93,500 | 24.5 | 34.0 | .27,* .22* | 27.0 | 170 | Do. |
| 1104 F | 2..... | 53,000 | 90,000 | 27.0 | 54.6 | .30,* .24* | ..... | ..... | Fine silky. |
| 1112 F | No. 2 Navy | 68,500 | 103,000 | 25.0 | 57.2 | .12, .38* | 27.5 | ..... | Do. |
| 1117 F | ...do..... | 56,000 | 101,500 | 24.5 | 51.9 | .13, .36* | 29.5 | ..... | Do. |
| 1145 F | No. 5 Navy | 57,000 | 100,500 | 24.5 | 49.1 | .14, .35* | ..... | ..... | Silky, cup shaped. |
| 1159 F | ...do..... | 42,500 | 78,500 | 30.5 | 49.1 | .42,* .19 | ..... | ..... | Silky. |
| 1185 F | 1..... | 41,000 | 59,000 | 36.0 | 66.9 | .21, .51* | ..... | ..... | Fine silky. |
| | | 50,000 | 64,500 | 37.0 | 62.2 | .24, .50* | 21.0 | ..... | Do. |
| 1207 F | No. 5 Navy | 46,500 | 89,000 | 23.5 | 57.2 | .10, .37* | ..... | ..... | Do. |
| 1221 F | ...do..... | 53,000 | 96,000 | 24.0 | 37.1 | .24,* .24* | 25.0 | ..... | Dull silky. |
| 1226 F | 2..... | 41,000 | 97,000 | 20.5 | 37.1 | .17, .24* | ..... | ..... | Fine granular, 90 per cent; silky, 10 per cent. |
| 1233 F [1] | ..... | 48,000 | 84,000 | 24.0 | 37.1 | .31,* .17 | 25.0 | ..... | Fine silky. |
| | | 60,000 | 103,500 | 17.5 | 34.0 | .09, .26* | 29.0 | ..... | Silky. |
| 1240 F | 3..... | 42,500 | 110,500 | 10.0 | 9.5 | .12* .08 | 30.0 | ..... | Fine granular. |
| 1248 F | 2..... | 64,000 | 115,000 | 9.5 | 13.2 | .12,* .07 | 32.0 | ..... | Do. |
| | | 35,000 | 75,000 | 29.5 | 54.6 | .41,* .18 | 24.0 | ..... | Fine silky. |
| | | 57,500 | 117,000 | 10.5 | 13.3 | .08, .13* | 30.5 | ..... | Fine granular. |
| 1258 F | 3..... | 53,500 | 111,000 | 15.0 | 20.5 | .10, .20* | 33.0 | ..... | Do. |
| 1264 F | 2..... | 76,500 | 134,000 | 8.0 | 13.2 | .11,* .05 | 35.0 | ..... | Fine granular, silky spot in center. |
| | | 73,500 | 127,500 | 10.5 | 13.2 | .14,* .07 | 34.0 | ..... | Fine granular, amorphous spot at center. |
| | | 72,000 | 134,500 | 10.0 | 13.3 | .07, .13* | 37.0 | ..... | Fine granular, silky spot at center. |
| 1272 F | No. 5 Navy | 57,000 | 101,500 | 22.0 | 34.0 | .23,* .21* | 26.0 | ..... | Fine silky, trace of granulation. |
| 1349 | B..... | 66,500 | 101,500 | 25.0 | 49.1 | .26,* .24 | 28.0 | ..... | Fine silky. |
| 1353 F | 2..... | 53,500 | 82,500 | 31.5 | 57.2 | .18, .45* | 25.0 | ..... | Do. |
| 1355 F | 3..... | 57,000 | 97,500 | 25.5 | 54.6 | .35,* .16 | 30.0 | ..... | Fine silky, cup shaped. |
| 1365 F | 1..... | 71,000 | 109,000 | 22.0 | 46.2 | .28,* .16 | 31.0 | ..... | Fine silky. |
| | | 68,000 | 104,000 | 24.0 | 51.9 | .13, .35* | 29.0 | ..... | Fine silky, cup shaped. |
| | | 40,000 | 63,100 | 36.5 | 67.0 | .21, .52* | 19.0 | ..... | Fine silky. |
| 1369 F | B..... | 114,500 | 130,000 | 19.5 | 62.2 | .07, .32* | 41.0 | ..... | Silky, cup shaped, serrated. |
| 1396 F | D..... | 127,000 | 143,500 | 17.5 | 54.6 | .28,* .07 | 41.0 | ..... | Fine silky, serrated. |
| 1414 | C..... | 117,500 | 134,500 | 18.5 | 57.2 | .28, .09 | 39.0 | ..... | Do. |
| 1424 F | A..... | 120,000 | 138,500 | 18.0 | 54.6 | .06, .30* | 40.0 | ..... | Do. |

*Forged steel from Watertown Arsenal smith shop*—Continued.

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* | *In.* | | | |
| 1440 F | 2 | 44,800 | 76,700 | 29.0 | 54.6 | 0.16, | 0.42* | 22.0 | ..... | Fine silky, cup shaped. |
| 1464 F | 4 | 47,000 | 87,500 | 30.5 | 54.6 | .41,* | .20 | 24.0 | ..... | Fine silky. |
| 1476 F | 2 | 48,000 | 93,000 | 27.0 | 46.2 | .34,* | .20 | 26.0 | ..... | Silky, cup shaped. |
| 1477 F | 1 | 43,000 | 87,000 | 22.5 | 51.9 | .36,* | .09 | 24.5 | ..... | Silky. |
| | | 41,500 | 86,500 | 29.5 | 54.6 | .40,* | .19 | 24.0 | ..... | Do. |
| 1481 F | No. 5 Navy | 50,000 | 94,000 | 24.0 | 37.1 | .24,* | .24* | 24.0 | ..... | Do. |
| 1505 F [1] | | 55,500 | 79,000 | 22.5 | 40.3 | .31,* | .14 | 26.5 | ..... | Fine silky. |
| | | 48,000 | 90,500 | 26.0 | 51.9 | .38,* | .14 | 25.5 | 293 | Silky. |
| | | 75,500 | 121,000 | 18.5 | 43.3 | .09, | .28* | 31.0 | 241 | Do. |
| | | 46,500 | 65,000 | 32.0 | 64.7 | .17, | .47* | 18.0 | ..... | Fine silky. |
| 1507 F | 3 | 62,000 | 77,000 | 24.0 | 65.4 | .32,* | .16 | 21.0 | ..... | Do. |
| | | 74,000 | 107,000 | 20.5 | 40.3 | .29,* | .12 | 33.0 | ..... | Do. |
| 1509 F | No. 5 Navy | 52,000 | 97,500 | 22.5 | 34.0 | .25,* | .20* | 24.5 | ..... | Dull silky. |
| 1525 F | A | 67,000 | 101,000 | 25.0 | 54.6 | .14, | .36* | 26.5 | ..... | Fine silky. |
| 1526 F | No. 5 Navy | 48,000 | 94,500 | 23.5 | 40.3 | .31,* | .16 | 25.0 | ..... | Dull silky. |
| | | 49,000 | 81,000 | 28.0 | 46.2 | .34,* | .22 | 22.5 | 137 | Fine silky; open longitudinal seam in stem. |
| 1538 F [1] | | 125,500 | 170,000 | 12.0 | 34.0 | .19,* | .05 | 45.0 | ..... | Silky. |
| 1539 F | 2 | 34,000 | 61,000 | 37.0 | 62.3 | .49,* | .25 | 19.0 | ..... | Fine silky. |
| | | 40,000 | 74,000 | 27.5 | 40.3 | .39,* | .16 | 21.0 | ..... | Silky. |
| 1540 F | No. 5 Navy | 75,500 | 117,000 | 22.5 | 54.6 | .29,* | .16 | 30.0 | ..... | Fine silky, serrated. |
| | | 48,000 | 85,000 | 28.5 | 51.9 | .26, | .31* | 21.5 | 149 | Fine silky, cup shaped. |
| 1565 F | 3 | 62,500 | 115,000 | 15.5 | 34.0 | .23,* | .08 | 30.5 | ..... | Fine granular, silky center. |
| 1573 F | 3 | 50,500 | 92,000 | 26.5 | 51.9 | .14, | .39* | 26.5 | ..... | Fine silky. |
| 1626 F | 3 | 77,000 | 109,500 | 21.5 | 51.9 | .27,* | .16 | 32.5 | ..... | Do. |
| 1686 F | 1 | 61,500 | 111,500 | 20.0 | 43.3 | .26,* | .14 | 28.5 | ..... | Silky. |
| | | 62,000 | 112,000 | 21.5 | 43.3 | .20, | .23* | 30.0 | ..... | Dull silky. |
| 1688 F | 2 | 62,500 | 96,500 | 26.0 | 51.9 | .35,* | .17 | 26.5 | ..... | Silky. |
| 1692 F | 3 | 53,500 | 95,500 | 24.5 | 40.3 | .17, | .32* | 23.5 | ..... | Do. |
| 1694 F | 2 | 47,000 | 80,000 | 30.0 | 51.9 | .42,* | .18 | 22.0 | ..... | Dull silky. |
| 1702 F | 3 | 46,500 | 94,000 | 22.0 | 30.7 | .27,* | .17 | 26.0 | ..... | Dull silky, trace of granulation. |
| | | 55,500 | 103,000 | 25.0 | 51.9 | .25,* | .25* | 26.0 | ..... | Silky. |
| 1704 F | C | 56,500 | 101,000 | 26.0 | 57.2 | .38,* | .14 | 28.0 | ..... | Fine silky. |
| | | 124,000 | 141,000 | 18.5 | 57.2 | .30* | .07 | 42 | ..... | Do. |
| 1705 F | 3 | 53,500 | 101,500 | 23.5 | 40.3 | .29,* | .18 | 28.0 | 187 | Silky. |
| 1753 F | 3 | 48,000 | 92,500 | 25.0 | 43.3 | .23, | .27* | 28.0 | ..... | Dull silky. |
| 1759 F | 3 | 50,000 | 98,500 | 24.0 | 46.2 | .23, | .25* | 27.5 | ..... | Silky. |
| 1783 F | A | 80,500 | 131,500 | 15.5 | 37.2 | .22,* | .09 | 36.0 | ..... | Silky, trace of granulation. |
| | | 54,000 | 123,000 | 15.0 | 40.3 | .09, | .21* | 32.0 | ..... | Fine silky. |
| | | 79,500 | 101,000 | 24.5 | 57.2 | .37,* | .12 | 28.0 | 212 | Silky serrated. |
| 1787 F | 2 | 26,500 | 57,500 | 39.5 | 69.2 | .56,* | .23 | 19.0 | ..... | Fine silky. |
| | | 51,500 | 91,000 | 22.5 | 40.3 | .30,* | .15 | 26.0 | 179 | Silky. |
| 1791 F | 3 | 56,000 | 93,500 | 26.0 | 46.2 | .32,* | .20 | 25.0 | ..... | Fine silky. |
| 1793 F | D | 82,500 | 112,500 | 16.0 | 43.3 | .06, | .26* | 34.0 | ..... | Do. |
| | | 118,500 | 137,000 | 19.5 | 59.8 | .07, | .32* | 40.5 | 277 | Fine silky, serrated. |
| 1795 F | 2 | 48,500 | 76,000 | 31.0 | 59.8 | .44,* | .18 | 21.0 | ..... | Fine silky. |
| 1799 F | No. 5 Navy | 67,000 | 111,000 | 22.0 | 54.6 | .34,* | .10 | 30.5 | 212 | Do. |
| 1800 F | ...do..... | 88,000 | 129,000 | 18.5 | 43.3 | .16, | .21* | 35.0 | 255 | Silky. |
| | | 108,500 | 131,000 | 18.5 | 57.2 | .27,* | .10 | 34.0 | 277 | Fine silky, serrated. |
| 1847 F | 3 | 50,000 | 93,500 | 25.0 | 43.3 | .15, | .35* | 24.0 | 170 | Silky. |
| 1901 | No. 5 Navy | 65,500 | 111,000 | 23.5 | 57.2 | .13, | .34* | 29.5 | 212 | Fine silky. |
| 1925 F | D | 64,500 | 105,500 | 24.0 | 46.2 | .13, | .35* | 27.5 | 187 | Silky. |
| | | 119,500 | 137,500 | 18.0 | 51.9 | .06, | .30* | 39.0 | 286 | Silky, serrated. |
| 1933 F | 3 | 49,500 | 93,000 | 24.0 | 40.3 | .32,* | .16 | 25.5 | 170 | Silky. |
| 1949 F | 3 | 47,500 | 92,500 | 21.0 | 27.4 | .20,* | .22* | 26.0 | 170 | Fine granular, 60 per cent; amorphous, 40 per cent. |
| 1965 F | 3 | 51,000 | 94,000 | 21.5 | 27.4 | .22,* | .21* | 27.0 | 179 | Fine granular, 75 per cent; amorphous, 25 per cent. |
| 1981 F | 2 | 50,500 | 93,500 | 23.0 | 40.3 | .29,* | .17 | 26.0 | 179 | Silky. |
| 1999 F | 3 | 50,000 | 99,500 | 22.5 | 40.3 | .14, | .31* | 26.5 | 187 | Silky, trace of granulation. |

[1] 60,000 lb. per sq. in. elastic limit required.

*Forged steel from Watertown Arsenal smith shop*—Continued.

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* | *In.* | | | |
| 2000 A F | 3 | 50,500 | 105,500 | 21.5 | 37.2 | 0.28,* | 0.15 | 27.0 | 202 | Dull silky. |
| 2009 F | 3 | 55,000 | 98,000 | 25.0 | 46.2 | .34,* | .20 | 26.5 | 187 | Silky. |
| 2025 F | No. 5 Navy | 51,000 | 93,000 | 30.0 | 54.6 | .19, | .41* | 26.0 | 174 | Fine silky. |
| 2073 F | 2 | 62,500 | 87,500 | 25.0 | 64.7 | .09, | .41* | 24.5 | 156 | Do. |
| 2090 F | D | 132,000 | 152,000 | 15.0 | 46.2 | .05, | .25* | 46.0 | 321 | Silky, serrated. |
| 2102 | D | 95,000 | 128,500 | 16.5 | 46.2 | .27,* | .06 | 34.0 | 241 | Silky. |
| 2103 F | 3 | 61,500 | 106,000 | 22.5 | 49.1 | .33,* | .12 | 27.0 | 202 | Do. |
| 2108 F | 2 | 50,000 | 102,000 | 18.0 | 30.7 | .23,* | .13 | 26.0 | 202 | Dull silky, 40 per cent; granular, 60 per cent. |
| | | 48,500 | 98,500 | 21.0 | 34.0 | .14, | .28* | 27.0 | 187 | Fine granular, 90 per cent; dull silky, 10 per cent. |
| 2109 F | 3 | 69,000 | 108,000 | 21.0 | 34.0 | .23,* | .19 | 28.0 | 207 | Silky. |
| 2141 F | 3 | 56,500 | 113,500 | 16.5 | 40.3 | .15,* | .18* | 30.0 | 223 | Dull silky. |
| 2146 F | No. 5 Navy | 31,000 | 53,000 | 38.5 | 67.0 | .22, | .55* | 17.0 | 95 | Fine silky. |
| | | 105,500 | 152,500 | 13.0 | 40.3 | .04, | .22* | 42.5 | 302 | Silky, trace of granulation. |
| 2203 F | 3 | 56,500 | 110,500 | 16.5 | 40.3 | .08, | .25* | 27.0 | 207 | Do. |
| 2219 F | D | 62,000 | 93,000 | 26.0 | 64.7 | .38,* | .14 | 28.0 | 192 | Fine silky. |
| | | 66,000 | 100,000 | 25.0 | 59.8 | .35,* | .15 | 26.0 | 207 | Do. |
| | | 131,500 | 165,000 | 10.0 | 40.3 | .18,* | .02 | 48.0 | 332 | Silky. |
| 2223 F | D | 154,000 | 180,500 | 10.5 | 40.3 | .03, | .18* | 50.0 | 375 | Silky, cup shaped. |
| | | 144,000 | 162,000 | 13.0 | 43.3 | .03, | .23* | 45.5 | 340 | Fine silky. |
| 2240 F | 3 | 49,000 | 93,500 | 24.0 | 43.3 | .21, | .27* | 27.0 | 183 | Silky. |
| 2272 F | 2 | 50,000 | 93,500 | 25.0 | 46.2 | .15, | .35* | 24.0 | 170 | Dull silky. |
| 2279 F | 2 | 47,000 | 91,000 | 23.5 | 40.3 | .23,* | .24* | 23.0 | 170 | Silky. |
| 2286 F | | 45,500 | 86,500 | 25.0 | 40.3 | .24*, | .26* | 22.5 | 159 | Do. |
| 2288 F | 3 | 46,500 | 87,000 | 24.0 | 30.7 | .24*, | .24* | 24.5 | 163 | Amorphous. |
| | | 54,000 | 97,000 | 20.5 | 30.7 | .19*, | .22* | 28.5 | 187 | Silky. |
| 2296 [1] | | 70,500 | 122,000 | 18.5 | 40.3 | .10, | .27* | 31.0 | 235 | Do. |
| 2298 F | 2 | 50,500 | 90,000 | 21.0 | 37.2 | .30*, | .12 | 26.5 | 170 | Dull silky. |
| 2299 F | Nickel steel No. 2. | 59,500 | 94,000 | 26.5 | 51.9 | .33*, | .20 | 25.5 | 179 | Fine silky; cup-shaped. |
| | | 60,000 | 93,500 | 26.5 | 49.1 | .26*, | .27* | 27.5 | 170 | Fine silky. |
| 2306 F | No. 5 Navy | 49,000 | 84,500 | 30.0 | 54.6 | .24, | .36* | 23.5 | 156 | Silky. |
| 1 F | B | 57,000 | 90,500 | 26.0 | 54.6 | .38*, | .14 | 23.0 | 170 | Fine silky; cup-shaped. |
| | | 61,500 | 91,000 | 27.0 | 54.6 | .34*, | .20 | 23.0 | 163 | Fine silky. |
| | | 61,500 | 93,500 | 25.5 | 54.6 | .38*, | .13 | 28.0 | 163 | Do. |
| | | 79,000 | 107,500 | 23.5 | 64.7 | .36*, | .11 | 28.0 | 207 | Do. |
| 11 F | B | 64,000 | 110,500 | 21.0 | 49.1 | .10, | .32* | 29.5 | 212 | Fine silky; cup-shaped. |
| | | 69,000 | 111,000 | 22.5 | 54.6 | .10, | .35* | 28.0 | 207 | Fine silky. |
| 17 F | B | 70,000 | 112,500 | 20.0 | 40.3 | .28*, | .12 | 30.0 | 212 | Do. |
| 18 F | B | 69,000 | 99,000 | 25.0 | 51.9 | .14, | .36* | 27.0 | 179 | Fine silky; cup-shaped. |
| 25 F | 3 | 48,500 | 95,500 | 20.0 | 27.4 | .21, | .19 | 26.0 | 179 | Fine granular, 80 per cent; dull silky, 20 per cent. |
| 29 F | D | 103,000 | 138,500 | 14.0 | 49.1 | .24*, | .04 | 42.0 | 302 | Fine silky. |
| 45 F | 3 | 60,000 | 101,000 | 17.0 | 49.1 | .07, | .27* | 28.0 | 187 | Fine silky; cup-shaped. |
| 78 F | 3 | 43,500 | 87,000 | 22.5 | 34.0 | .31*, | .14 | 26.5 | 163 | Dull silky. |
| | | 50,500 | 98,500 | 22.5 | 40.3 | .28*, | .17 | 25.0 | 179 | Silky. |
| 81 F | 2 | 55,000 | 93,500 | 26.0 | 49.1 | .15, | .37* | 24.5 | 163 | Do. |
| 85 F | 3 | 35,500 | 70,000 | 31.0 | 49.1 | .33*, | .29* | 21.0 | 126 | Fine silky. |
| | | 69,500 | 106,000 | 16.0 | 30.7 | .20*, | .12 | 32.5 | 217 | Dull silky, 40 per cent; fine granular, 60 per cent. |
| 86 F | Nickel steel No. 2. | 52,000 | 85,500 | 25.0 | 54.6 | .12, | .38* | 24.0 | 179 | Silky. |
| | | 63,000 | 96,000 | 28.0 | 57.2 | .35*, | .21 | 23.5 | 183 | Silky; cup-shaped. |
| 87 F | A | 68,500 | 108,500 | 26.0 | 57.2 | .22, | .30* | 28.0 | 207 | Fine silky. |
| 95 F | A | 66,000 | 98,500 | 27.0 | 57.2 | .35*, | .19 | 28.0 | 192 | Do. |
| 127 F | 2 | 46,000 | 96,500 | 23.0 | 40.3 | .18, | .28* | 26.5 | 179 | Silky. |
| 128 F | 3 | 47,000 | 96,000 | 22.0 | 34.0 | .18, | .26* | 25.0 | 179 | Do. |
| 163 F | C and D | 157,000 | 183,000 | 1.0 | 1.8 | .01, | .01 | 53.5 | 387 | Fine granular. |
| | | 128,500 | 153,000 | 11.5 | 27.4 | .05, | .18* | 45.0 | 302 | Silky. |
| | | 105,000 | 143,500 | 14.5 | 46.2 | .24*, | .05 | 36.0 | 286 | Fine silky. |

[1] 60,000 lb. per sq. in. elastic limit required.

*Forged steel from Watertown Arsenal smith shop*—Continued.

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* *In.* | | | |
| 181 F | 3..... | 40,000 | 80,500 | 24.5 | 59.8 | 0.17, 0.32* | 25.0 | 149 | Silky. |
| | | 61,500 | 116,500 | 18.5 | 34.0 | .12, .25* | 29.0 | 217 | Silky; trace of granulation. |
| 186 F | Nickel steel No. 2. | 67,500 | 96,000 | 27.5 | 59.8 | .39*, .16 | 25.0 | 179 | Fine silky; cup-shaped. |
| 187 F | ...do..... | 66,000 | 95,000 | 27.5 | 59.8 | .39*, .16 | 25.0 | 174 | Fine silky. |
| 188 F | ...do..... | 61,500 | 90,000 | 28.0 | 57.2 | .39*, .17 | 23.5 | 170 | Do. |
| 189 F | ...do..... | 68,000 | 98,500 | 26.5 | 59.8 | .39*, .14 | 26.5 | 183 | Do. |
| 190 F | ...do..... | 67,000 | 96,000 | 27.5 | 59.8 | .37*, .18 | 24.5 | 179 | Do. |
| 191 F | ...do..... | 66,000 | 95,500 | 28.0 | 59.8 | .16, .40* | 25.5 | 179 | Fine silky; cup-shaped. |
| 192 F | ...do..... | 66,300 | 95,400 | 28.5 | 59.1 | .18, .39* | 25.5 | 174 | Fine silky. |
| 193 F | ...do..... | 69,000 | 96,000 | 28.0 | 59.8 | .16, .40* | 24.0 | 179 | Fine silky; cup-shaped. |
| 195 F | No. 5 Navy | 43,000 | 84,500 | 27.5 | 43.3 | .23, .32* | 23.5 | 156 | Silky. |
| 200 F | Nickel steel No. 2. | 50,500 | 91,000 | 26.0 | 59.8 | .13, .39* | 23.0 | 170 | Fine silky. |
| | | 84,000 | 113,500 | 18.5 | 43.3 | .26*, .11 | 32.0 | 235 | Silky. |
| 201 F | ...do..... | 62,500 | 92,000 | 21.5 | 34.0 | .19, .24* | 22.0 | 166 | Silky, oblique. |
| 204 F | ...do..... | 64,500 | 96,500 | 26.0 | 46.2 | .17, .35* | 25.0 | 179 | Fine silky. |
| 205 F | ...do..... | 58,000 | 89,500 | 25.5 | 46.2 | .37*, .14 | 23.0 | 163 | Do. |
| 206 F | ...do..... | 56,000 | 90,000 | 29.0 | 57.2 | .38*, .20 | 23.0 | 166 | Fine silky; cup-shaped. |
| 207 F | ...do..... | 86,000 | 119,000 | 11.0 | 16.9 | .13*, .09 | 25.0 | 228 | Fine granular, 70 per cent; dull silky, 30 per cent. |
| 209 F | ...do..... | 79,000 | 109,000 | 22.5 | 59.8 | .31*, .14 | 30.5 | 228 | Fine silky. |
| 210 F | No. 5 Navy | 43,500 | 84,500 | 28.5 | 46.2 | .34*, .23 | 24.0 | 156 | Silky. |
| 211 F | ...do..... | 39,000 | 82,000 | 18.5 | 27.4 | .25*, .12 | 23.0 | 153 | Lamellar. |
| 212 F | ...do..... | 40,000 | 76,000 | 23.5 | 46.2 | .10, .37* | 22.0 | 137 | Silky. |
| 215 F | 3..... | 49,500 | 90,500 | 26.0 | 37.2 | .27*, .25* | 24.0 | 163 | Fine silky. |
| 221 F | No. 5 Navy | 48,000 | 84,500 | 29.5 | 51.9 | .25, .34* | 25.0 | 156 | Do. |
| 226 F | D..... | 145,000 | 160,000 | 12.5 | 46.2 | .03, .22* | 42.5 | 332 | Do. |
| | | 134,000 | 166,500 | 13.5 | 40.3 | .05, .22* | 44.0 | 293 | Do. |
| | | 145,600 | 160,400 | 13.0 | 42.5 | .20*, .06 | 39.0 | 340 | Do. |
| 229 F | B..... | 60,000 | 109,000 | 23.0 | 49.1 | .22*, .24* | 27.0 | 207 | Do. |
| | | 68,500 | 108,500 | 23.5 | 49.1 | .17, .30* | 27.0 | 207 | Silky. |
| | | 68,000 | 108,000 | 21.5 | 40.3 | .19, .24* | 26.5 | 207 | Fine silky; cup-shaped. |
| 230 F | B..... | 66,000 | 109,000 | 22.0 | 51.9 | .33*, .11 | 28.0 | 212 | Do. |
| 231 F | 3..... | 47,000 | 88,000 | 22.5 | 37.2 | .30*, .15 | 23.0 | 156 | Silky. |
| 234 F | 2..... | 38,000 | 82,500 | 27.5 | 57.2 | .19, .36* | 23.0 | 159 | Fine silky. |
| 240 F | No. 5 Navy | 42,000 | 91,000 | 26.5 | 43.3 | .25, .28* | 24.0 | 163 | Dull silky. |
| 244 F | Nickel steel No. 2. | 70,000 | 94,000 | 26.0 | 58.0 | .28*, .24 | 22.5 | 170 | Fine silky. |
| 247 F | No. 5 Navy | 46,000 | 83,000 | 25.5 | 49.1 | .36*, .15 | 22.0 | 149 | Silky. |
| 253 F | 3..... | 40,500 | 83,500 | 27.5 | 46.2 | .32*, .23 | 22.0 | 163 | Do. |
| | | 46,500 | 93,500 | 25.0 | 46.2 | .21, .29* | 23.0 | 174 | Silky; cup-shaped. |
| 255 F | 2..... | 43,000 | 80,000 | 27.5 | 49.1 | .16, .39* | 20.5 | 143 | Silky. |
| 256 F | Nickel steel No. 2. | 58,500 | 101,500 | 24.0 | 51.9 | .17, .31* | 26.5 | 170 | Do. |
| 257 F | ...do..... | 67,500 | 97,500 | 24.0 | 40.3 | .24*, .24* | 25.0 | 179 | Fine silky. |
| 268 F | 3..... | 54,000 | 95,500 | 27.5 | 51.9 | .16, .39* | 22.0 | 170 | Silky. |
| 270 F | A..... | 60,000 | 96,500 | 27.0 | 54.6 | .30*, .24* | 22.5 | 179 | Fine silky. |
| 273 F | 3..... | 58,000 | 106,000 | 18.0 | 43.3 | .10, .26* | 25.0 | 187 | Silky. |
| 282 F | 2..... | 52,500 | 89,500 | 26.5 | 49.1 | .36*, .17 | 23.0 | 163 | Dull silky. |
| 283 F | 2..... | 51,000 | 95,000 | 25.0 | 46.2 | .29*, .21 | 24.0 | 170 | Do. |
| 295 F | 3..... | 53,400 | 94,900 | 22.0 | 47.9 | .28*, .16 | 30.0 | 143 | Silky. |
| 334 F | 3..... | 62,000 | 103,000 | 23.0 | 37.2 | .21*, .25* | 26.5 | 196 | Do. |
| 335 F | 3..... | 46,500 | 93,000 | 23.0 | 43.3 | .14, .32* | 25.0 | 174 | Do. |
| 337 F | 3..... | 45,500 | 86,000 | 26.0 | 43.3 | .19, .33* | 22.0 | 163 | Do. |
| 338 F | C..... | 69,500 | 105,000 | 24.5 | 51.9 | .35*, .14 | 28.0 | 196 | Fine silky; cup-shaped. |
| | | 70,000 | 105,000 | 25.5 | 49.1 | .26*, .25* | 23.5 | 187 | Fine silky. |
| 339 F | C..... | 60,500 | 103,000 | 24.0 | 46.2 | .30*, .18 | 26.5 | 192 | Do. |
| | | 68,500 | 104,000 | 25.0 | 51.9 | .28*, .22* | 24.0 | 196 | Do. |
| 343 F | 3..... | 47,500 | 78,500 | 32.5 | 54.6 | .42*, .23 | 21.0 | 143 | Do. |
| 344 F | 3..... | 39,500 | 83,500 | 28.5 | 49.1 | .38*, .19 | 22.5 | 146 | Dull silky. |
| 345 F | 3..... | 42,000 | 80,500 | 29.5 | 49.1 | .31*, .28* | 21.0 | 146 | Fine silky. |

*Forged steel from Watertown Arsenal smith shop*—Continued.

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* *In.* | | | |
| 346 F | 3 | 45,000 | 80,500 | 29.5 | 49.1 | 0.28, 0.31* | 21.5 | 153 | Fine silky; cup-shaped. |
| 347 F | 3 | 43,500 | 82,000 | 29.5 | 51.9 | .38*, .21 | 21.5 | 149 | Silky. |
| 348 F | 3 | 44,000 | 81,000 | 29.5 | 51.9 | .38*, .21 | 23.0 | 146 | Do. |
| 349 F | 3 | 39,000 | 81,500 | 26.5 | 49.1 | .38*, .15 | 22.0 | 146 | Do. |
| 350 F | 3 | 40,500 | 81,500 | 30.5 | 51.9 | .36*, .25 | 21.5 | 156 | Do. |
| 351 F | 3 | 48,500 | 79,500 | 31.5 | 49.1 | .31*, .32* | 22.0 | 146 | Fine silky. |
| 352 F | 3 | 44,000 | 87,000 | 26.5 | 46.2 | .17, .36* | 23.0 | 163 | Silky. |
| 353 F | 3 | 44,000 | 87,500 | 26.0 | 46.2 | .15, .37* | 23.0 | 159 | Do. |
| 354 F | 3 | 44,500 | 85,000 | 27.5 | 49.1 | .36*, .19 | 23.0 | 149 | Do. |
| 355 F | 3 | 50,000 | 95,000 | 21.5 | 40.3 | .29*, .14 | 24.0 | 183 | Do. |
| 356 F | 1 | 48,000 | 100,500 | 21.0 | 37.2 | .13, .29* | 27.5 | 196 | Dull silky; trace of granulation. |
| | | 50,500 | 93,500 | 24.0 | 43.3 | .28*, .20 | 24.0 | 196 | Silky. |
| 357 F | 3 | 54,500 | 86,000 | 22.5 | 51.9 | .15, .30* | 24.0 | 146 | Silky; cup-shaped. |
| 369 F | 3 | 47,500 | 89,500 | 27.5 | 49.1 | .22, .33* | 22.0 | 156 | Silky. |
| 370 F | 3 | 39,500 | 75,500 | 8.5 | 16.9 | .11*, .06 | 27.0 | 179 | Silky, 85 per cent; lamellar, 15 per cent. |
| | | 44,500 | 95,500 | 23.5 | 37.2 | .30*, .17 | 25.0 | 183 | Dull silky; trace of granulation. |
| 371 F | 3 | 51,000 | 88,500 | 27.0 | 46.2 | .36*, .18 | 24.0 | 159 | Fine silky. |
| 372 F | 3 | 48,500 | 96,000 | 22.5 | 37.2 | .22*, .23* | 24.0 | 183 | Silky. |
| 373 F | 3 | 66,500 | 99,000 | 22.5 | 43.3 | .15, .30* | 24.0 | 183 | Do. |
| 374 F | 3 | 47,500 | 96,000 | 22.5 | 40.3 | .13, .32* | 25.0 | 183 | Do. |
| 375 F | 3 | 50,500 | 94,500 | 25.0 | 43.3 | .19, .31* | 25.0 | 170 | Do. |
| 376 F | 3 | 48,500 | 91,000 | 27.0 | 46.2 | .36*, .18 | 24.0 | 159 | Do. |
| 377 F | 3 | 54,000 | 91,000 | 24.5 | 46.2 | .15, .34* | 24.0 | 170 | Do. |
| 378 F | 3 | 54,500 | 98,000 | 23.0 | 43.3 | .31*, .15 | 25.0 | 179 | Do. |
| 379 F | 3 | 53,500 | 97,000 | 22.0 | 40.3 | .32*, .12 | 24.0 | 179 | Do. |
| 380 F | 3 | 49,000 | 103,500 | 18.0 | 24.0 | .23*, .13 | 26.5 | 187 | Fine granular, 90 per cent; silky, 10 per cent. |
| 381 F | D | 167,500 | 180,500 | 8.5 | 37.2 | .16*, .01 | 52.0 | 351 | Fine silky; cup-shaped. |
| | | 120,000 | 138,500 | 19.0 | 54.6 | .19*, .19* | 38.5 | 277 | Fine silky; serrated. |
| 382 F | 3 | 44,500 | 88,000 | 27.0 | 46.2 | .28*, .26* | 22.0 | 163 | Silky. |
| 384 F | 2 | 55,000 | 98,000 | 25.5 | 57.2 | .13, .38* | 24.0 | 192 | Fine silky. |
| 408 F | C | 73,500 | 120,000 | 17.0 | 49.1 | .27*, .07 | 31.0 | 255 | Do. |
| 409 F | C | 65,400 | 112,700 | 21.0 | 54.7 | .32*, .10 | 28.0 | 217 | Fine silky; cup shaped. |
| 410 F | C | 70,500 | 118,000 | 21.0 | 59.8 | .33*, .09 | 28.0 | 217 | Fine silky. |
| 411 F | C | 68,500 | 114,000 | 22.0 | 54.6 | .11, .33* | 28.0 | 217 | Fine silky; cup shaped. |
| 412 F | C | 69,500 | 118,500 | 21.0 | 54.6 | .30*, .12 | 29.0 | 235 | Fine silky. |
| 413 F | C | 70,500 | 118,000 | 22.0 | 57.2 | .24*, .20* | 28.0 | 228 | Do. |
| 414 F | C | 66,500 | 114,000 | 22.0 | 54.6 | .13, .31* | 29.0 | 217 | Do. |
| 415 F | C | 70,500 | 117,000 | 22.0 | 51.9 | .14, .30* | 29.0 | 212 | Do. |
| 416 F | C | 73,000 | 122,000 | 17.0 | 46.2 | .27*, .07 | 30.0 | 241 | Do. |
| 417 F | C | 75,500 | 114,000 | 24.0 | 59.8 | .17, .31* | 28.5 | 217 | Do. |
| 418 F | C | 72,500 | 109,500 | 23.0 | 59.8 | .10, .36* | 26.0 | 212 | Fine silky; cup shaped. |
| 419 F | C | 71,000 | 117,500 | 21.0 | 54.6 | .24*, .18 | 27.0 | 235 | Fine silky. |
| 420 F | C | 72,500 | 115,500 | 22.0 | 57.2 | .32*, .12 | 28.0 | 212 | Fine silky; cup shaped. |
| 421 F | C | 70,500 | 116,500 | 20.5 | 54.6 | .10, .31* | 28.5 | 212 | Fine silky. |
| 422 F | C | 69,500 | 117,000 | 21.5 | 57.2 | .12, .31* | 27.0 | 228 | Do. |
| 423 F | C | 71,000 | 120,000 | 19.5 | 51.9 | .10, .29* | 30.0 | 241 | Do. |
| 424 F | C | 70,000 | 117,500 | 21.0 | 57.2 | .10, .32* | 27.0 | 228 | Do. |
| 425 F | C | 71,000 | 118,500 | 21.0 | 54.6 | .32*, .10 | 28.0 | 223 | Do. |
| 426 F | C | 70,000 | 119,000 | 21.0 | 54.6 | .31*, .11 | 27.0 | 228 | Fine silky; cup shaped. |
| 427 F | C | 74,500 | 115,000 | 23.0 | 59.8 | .34*, .12 | 28.0 | 228 | Fine silky. |
| 428 F | C | 70,500 | 116,500 | 22.5 | 57.2 | .33*, .12 | 27.5 | 228 | Fine silky; cup shaped. |
| 429 F | C | 73,000 | 115,000 | 23.5 | 57.2 | .21, .26* | 28.0 | 228 | Do. |
| 430 F | C | 81,000 | 112,000 | 18.5 | 46.2 | .17, .20* | 30.0 | 228 | Fine silky. |
| 431 F | C | 69,000 | 116,000 | 22.0 | 54.6 | .29*, .15 | 29.5 | 217 | Do. |
| 432 F | B | 88,500 | 117,000 | 21.0 | 57.2 | .33*, .09 | 34.0 | 255 | Do. |
| 448 F | A | 57,500 | 102,500 | 22.0 | 46.2 | .12, .32* | 25.0 | 202 | Silky. |
| 449 F | A | 60,500 | 98,500 | 25.5 | 54.6 | .34*, .17 | 24.5 | 196 | Do. |
| 450 F | A | 60,500 | 98,500 | 23.5 | 54.6 | .37*, .10 | 25.5 | 183 | Do. |

*Forged steel from Watertown Arsenal smith shop*—Continued.

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction of area. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *Per cent.* | *Per cent.* | *In.* *In.* | | | |
| 451 F | A | 55,500 | 98,000 | 24.0 | 54.6 | 0.36*, 0.12 | 24.0 | 187 | Silky. |
| 452 F | A | 59,000 | 98,000 | 25.5 | 54.6 | .37*, .14 | 24.0 | 192 | Do. |
| 453 F | A | 58,000 | 98,500 | 25.0 | 51.9 | .18, .32* | 24.5 | 196 | Do. |
| 454 F | A | 60,000 | 97,000 | 26.5 | 54.6 | .16, .37* | 24.0 | 183 | Do. |
| 455 F | A | 66,500 | 96,500 | 26.5 | 54.6 | .19, .34* | 23.0 | 183 | Do. |
| 456 F | A | 66,000 | 102,000 | 23.5 | 57.2 | .35*, .12 | 25.5 | 207 | Do. |
| 457 F | A | 64,000 | 102,500 | 24.0 | 54.6 | .21, .27* | 25.5 | 196 | Do. |
| 458 F | A | 63,000 | 105,000 | 23.0 | 54.6 | .12, .34* | 25.0 | 196 | Do. |
| 459 F | A | 64,500 | 103,000 | 25.0 | 57.2 | .37*, .13 | 25.0 | 207 | Do. |
| 460 F | A | 60,500 | 98,000 | 23.5 | 43.3 | .24*, .23* | 24.5 | 187 | Do. |
| 461 F | B | 71,500 | 120,500 | 19.0 | 46.2 | .28*, .10 | 28.5 | 228 | Do. |
| 462 F | D | 124,500 | 146,000 | 15.5 | 49.1 | .06, .25* | 39.0 | 302 | Fine silky; serrated. |
| 463 F | 3 | 49,500 | 96,000 | 23.0 | 40.3 | .16, .30* | 25.5 | 183 | Dull silky. |
| 475 F-C | D | 89,500 | 120,000 | 8.5 | 9.5 | .09*, .08* | 33.0 | 228 | Fine granular. |
| 475 F-T | D | 79,500 | 123,500 | 11.5 | 20.5 | .07, .16* | 32.0 | 235 | Fine granular, silky center. |
| 475 F-L | | 68,500 | 116,000 | 18.0 | 30.7 | .22*, .14* | 29.0 | 217 | Silky; trace granulation. |
| 477 F | B | 52,500 | 85,500 | 29.5 | 51.9 | .29*, .30* | 21.0 | 156 | Fine silky. |
| | | 57,500 | 100,000 | 20.5 | 37.2 | .14, .27* | 24.0 | 170 | Silky. |
| 479 F | B | 58,000 | 99,000 | 23.5 | 43.3 | .25*, .22 | 25.0 | 187 | Fine silky. |
| | | 65,000 | 115,000 | 18.0 | 37.2 | .12, .24* | 24.5 | 217 | Silky. |
| 480 F | B | 58,000 | 87,500 | 28.5 | 57.2 | .40*, .17 | 22.5 | 163 | Fine silky. |
| | | 57,000 | 96,000 | 24.0 | 51.9 | .35*, .13 | 23.0 | 179 | Silky. |
| 486 F | 2 | 52,000 | 92,500 | 23.5 | 49.1 | .11, .36* | 24.0 | 170 | Do. |
| 512 F | B | 62,000 | 105,500 | 20.0 | 43.3 | .30*, .10 | 25.0 | 196 | Do. |
| 513 F | B | 62,500 | 103,500 | 22.5 | 40.3 | .22*, .23 | 24.0 | 196 | Fine silky. |
| 514 F | B | 65,000 | 105,000 | 21.5 | 37.2 | .23*, .20* | 25.0 | 196 | Do. |
| 515 F | B | 64,500 | 101,000 | 24.0 | 49.1 | .32*, .16 | 24.5 | 196 | Fine silky; cup shaped. |
| 516 F | B | 63,000 | 106,000 | 23.5 | 46.2 | .29*, .18 | 24.0 | 196 | Do. |
| 517 F | B | 65,000 | 101,500 | 22.5 | 49.1 | .34*, .11 | 22.0 | 187 | Silky. |
| 518 F | B | 63,000 | 105,000 | 21.5 | 46.2 | .11, .32* | 23.0 | 192 | Do. |
| 519 F | B | 62,000 | 104,000 | 23.0 | 46.2 | .32*, .14 | 24.0 | 187 | Do. |
| 520 F | 2 | 50,000 | 103,500 | 20.0 | 37.2 | .23*, .17 | 24.5 | 202 | Dull silky; trace of granulation. |
| 532 F | 2 | 61,500 | 95,500 | 26.0 | 57.2 | .15, .37* | 24.5 | 183 | Fine silky. |
| 536 F | No. 5 Navy | 65,500 | 101,500 | 19.0 | 49.1 | .07, .31* | 26.0 | 192 | Silky. |
| 548 F | ...do | 55,000 | 106,500 | 16.5 | 24.0 | .22*, .11 | 28.0 | 187 | Fine granular, 70 per cent; Amorphous, 30 per cent. |
| | | 49,500 | 102,500 | 20.5 | 34.0 | .22*, .19 | 27.0 | 192 | Amorphous, 50 per cent; granular 50 per cent. |
| 549 F | 3 | 57,000 | 107,000 | 19.5 | 37.2 | .20*, .19 | 25.0 | 207 | Silky. |
| 555 F | 3 | 54,000 | 98,500 | 19.0 | 40.3 | .10, .28* | 24.0 | 187 | Do. |
| 582 F | 3 | 55,000 | 97,500 | 13.5 | 46.2 | .22*, .05 | 29.0 | 212 | Fine silky. |
| 845 F | 6 | 59,000 | 103,500 | 20.0 | 46.2 | .09, .31* | 23.5 | 179 | Silky. |

*Forged steel from Watertown Arsenal smith shop*—Continued.

EXPERIMENTAL TESTS FOR STUDENT OFFICERS.

| Marks. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Shore. | Brinell. | |
| | *Lbs.* | *Lbs.* | *P. ct.* | *P. ct.* | *In. In.* | | | |
| A-2..... | 63,000 | 97,500 | 26.5 | 54.6 | 0.16, 0.37* | 26.0 | ..... | Fine silky. |
| B-2..... | 60,000 | 98,500 | 25.0 | 51.9 | .19, .31* | 26.0 | ..... | Do. |
| C-2..... | 57,000 | 95,000 | 26.0 | 51.9 | .34,* .18 | 26.0 | ..... | Do. |
| D-2..... | 62,000 | 99,000 | 25.0 | 51.9 | .34,* .16 | 27.0 | ..... | Do. |
| A-3..... | 70,500 | 116,000 | 19.5 | 43.3 | .10, .29* | 33.0 | ..... | Do. |
| B-3..... | 70,500 | 115,000 | 20.0 | 46.2 | .09, .31* | 33.0 | ..... | Do. |
| C-3..... | 73,500 | 118,000 | 18.0 | 43.3 | .08, .28* | 32.0 | ..... | Do. |
| D-3..... | 77,500 | 120,000 | 18.5 | 46.2 | .12, .25* | 34.0 | ..... | Do. |
| E-3..... | 65,000 | 103,500 | 8.0 | 9.5 | .07, .09* | 31.0 | ..... | Silky, 90 per cent; fine granular, 10 per cent. |
| A-4..... | 70,000 | 113,000 | 18.0 | 46.2 | .07, .29* | 30.0 | ..... | Fine silky. |
| B-4..... | 91,000 | 129,500 | 13.5 | 34.0 | .20,* .07 | 36.0 | ..... | Silky. |
| C-4..... | 79,500 | 120,000 | 17.5 | 43.3 | .22,* .13 | 34.0 | ..... | Fine silky. |
| D-4..... | 96,500 | 132,000 | 9.0 | 24.0 | .04, .14* | 37.5 | ..... | Fine granular, silky spot at circumference. |
| E-4..... | 81,000 | 118,500 | 6.5 | 9.5 | .06, .07* | 35.0 | ..... | Fine granular, 70 per cent; amorphous, 30 per cent. |
| A-5..... | 82,000 | 115,000 | 16.0 | 46.2 | .04, .28* | 32.0 | ..... | Fine silky. |
| B-5..... | 75,000 | 108,000 | 17.5 | 43.3 | .28,* .07 | 30.0 | ..... | Do. |
| C-5..... | 83,500 | 120,000 | 18.0 | 37.1 | .10, .26* | 33.0 | ..... | Do. |
| D-5..... | 81,500 | 123,500 | 9.5 | 24.0 | .14,* .05 | 36.0 | ..... | Silky oblique. |
| E-5..... | 86,000 | 105,000 | 5.0 | 9.5 | .07,* .03 | 36.0 | ..... | Amorphous, 95 per cent; fine granular, 5 per cent. |
| A-6..... | 59,500 | 91,000 | 27.5 | 57.2 | .20, .35* | 25.0 | ..... | Fine silky, cup shaped. |
| B-6..... | 65,500 | 94,500 | 23.5 | 49.1 | .12, .35* | 26.0 | ..... | Fine silky. |
| C-6..... | 66,000 | 95,500 | 26.5 | 49.1 | .37,* .16 | 29.0 | ..... | Do. |
| D-6..... | 62,000 | 93,000 | 30.0 | 62.2 | .38,* .22 | 25.5 | ..... | Fine silky, serrated. |
| E-6..... | 67,000 | 92,500 | 8.5 | 13.2 | .10,* .07 | 26.0 | ..... | Dull silky, 90 per cent; fine granular, 10 per cent. |
| A-7..... | 57,500 | 92,500 | 27.5 | 54.6 | .39,* .16 | 25.0 | ..... | Fine silky. |
| B-7..... | 59,500 | 91,500 | 26.0 | 43.3 | .19, .33* | 25.0 | ..... | Do. |
| C-7..... | 59,500 | 91,500 | 26.5 | 43.3 | .22, .31* | 25.5 | ..... | Do. |
| D-7..... | 57,500 | 90,000 | 28.5 | 54.6 | .18, .39* | 27.0 | ..... | Fine silky, cup shaped. |
| E-7..... | 57,500 | 92,500 | 23.0 | 34.0 | .21, .25* | 25.5 | ..... | Silky. |
| A-8..... | 44,500 | 82,000 | 27.5 | 43.3 | .19, .36* | 24.0 | ..... | Dull silky. |
| B-8..... | 44,500 | 82,000 | 25.5 | 40.3 | .19, .32* | 26.0 | ..... | Dull silky, trace of granulation. |
| C-8..... | 44,500 | 82,500 | 26.0 | 40.3 | .34,* .18 | 24.0 | ..... | Dull silky. |
| D-8..... | 44,000 | 81,500 | 27.0 | 43.3 | .24, .30* | 20.0 | ..... | Do. |
| E-8..... | 40,000 | 80,000 | 10.5 | 9.5 | .12,* .09 | 21.5 | ..... | Fine granular. |
| A-9..... | 46,000 | 96,500 | 21.0 | 34.0 | .13, .29* | 25.0 | ..... | Fine granular, 70 per cent; dull silky, 30 per cent. |
| B-9..... | 50,000 | 97,500 | 20.0 | 30.7 | .26,* .14 | 25.0 | ..... | Fine granular, 85 per cent; dull silky, 15 per cent. |
| C-9..... | 47,500 | 95,500 | 22.0 | 34.0 | .23,* .21 | 24.5 | ..... | Fine granular, 80 per cent; dull silky, 20 per cent. |
| D-9..... | 47,000 | 95,000 | 20.0 | 34.0 | .28,* .12 | 24.0 | ..... | Fine granular, 60 per cent; dull silky, 40 per cent. |
| E-9..... | 52,500 | 92,000 | 5.5 | 5.7 | .04, .07* | 26.5 | ..... | Fine granular. |
| A-10..... | 47,000 | 93,500 | 22.5 | 40.3 | .13, .32* | 23.5 | ..... | Silky, trace of granulation. |
| B-10..... | 47,000 | 94,000 | 22.5 | 40.3 | .29,* .16 | 24.0 | ..... | Dull silky. |
| C-10..... | 46,000 | 94,000 | 22.5 | 30.7 | .23,* .22 | 25.0 | ..... | Fine granular, silky spot at circumference. |
| D-10..... | 48,000 | 96,500 | 22.5 | 37.2 | .15, .30* | 25.0 | ..... | Dull silky. |
| E-10..... | 47,500 | 93,000 | 7.5 | 5.7 | .08,* .07 | 24.5 | ..... | Fine granular. |
| S.O.O.... | 56,500 | 117,500 | 14.0 | 16.9 | .08, .20* | 29.0 | ..... | Granular, 80 per cent; dull silky, 20 per cent. |
| S.O.A-1.. | 94,500 | 160,000 | 11.0 | 27.4 | .05, .17* | 44.0 | ..... | Granular, 85 per cent; dull silky, 15 per cent. |
| S.O.A-2.. | 58,000 | 121,500 | 16.0 | 27.4 | .10, .22* | 31.0 | ..... | Granular, 80 per cent; dull silky, 20 per cent. |
| S.O.A-3.. | 49,000 | 112,000 | 15.0 | 16.9 | .12, .18* | 31.0 | ..... | Granular, 90 per cent; dull silky, 10 per cent. |
| S.O.B-1.. | 126,500 | 171,000 | 8.5 | 13.3 | .06, .11* | 45.0 | ..... | Fine granular. |
| S.O.B-2.. | 66,500 | 127,000 | 14.0 | 27.4 | .09, .19* | 32.0 | ..... | Granular, 70 per cent; dull silky, 30 per cent. |
| S.O.B-3.. | 89,500 | 109,000 | 11.5 | 24.0 | .18,* .05 | 29.0 | ..... | Granular, 80 per cent; dull silky, 20 per cent. |
| S.O.C-1.. | 50,000 | 102,500 | 18.5 | 30.7 | .11, .26* | 28.0 | ..... | Fine granular, amorphous spot at center. |
| S.O.C-2.. | 48,500 | 100,000 | 20.0 | 34.0 | .29,* .11 | 28.0 | ..... | Fine granular, 50 per cent; amorphous, 50 per cent. |
| S.O.C-3.. | 54,000 | 111,500 | 17.5 | 24.0 | .19,* .16* | 29.5 | ..... | Fine granular, amorphous spot at circumference. |

*Forged steel from Watertown Arsenal smith shop*—Continued.

| Marks. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Shore. | Brinell. | |
| | *Lbs.* | *Lbs.* | *P. ct.* | *P. ct.* | *In. In.* | | | |
| S.O.D-1.. | 52,500 | 107,000 | 17.5 | 30.7 | 0.25,*0.10 | 27.5 | ..... | Fine granular, 50 per cent; amorphous, 50 per cent. |
| S.O.D-2.. | 53,500 | 107,000 | 16.0 | 27.4 | .23,* .09 | 27.5 | ..... | Fine granular, amorphous spot at center. |
| S.O.D-3.. | 51,000 | 101,500 | 19.5 | 34.0 | .11, .28* | 26.0 | ..... | Amorphous, fine granular at circumference. |
| S.O.E-1 . | 100,500 | 160,500 | 12.5 | 34.0 | .05, .20* | 43.0 | 302 | Fine granular, 80 per cent; dull silky, 20 per cent. |
| S.O.E-2 . | 59,000 | 116,500 | 18.0 | 34.0 | .25*, .11 | 28.0 | 312 | Fine granular, 50 per cent; dull silky, 50 per cent. |
| S.O.E-3 . | 44,000 | 97,500 | 19.0 | 37.2 | .17, .21* | 25.5 | 192 | Fine granular, 75 per cent; dull silky, 25 per cent. |
| S.O.F-1 . | 116,500 | 162,000 | 10.0 | 24.0 | .15*, .05 | 40.5 | 311 | Fine granular, 80 per cent; dull silky, 20 per cent. |
| S.O.F-2 . | 64,000 | 126,500 | 13.5 | 27.4 | .14*, .13 | 30.5 | 255 | Do. |
| S.O.F-3 . | 51,800 | 112,700 | 14.0 | 21.8 | .10, 18* | ..... | 202 | Fine granular; dull silky spot at circumference. |
| S.O.F-4 . | 48,500 | 111,000 | 15.5 | 20.5 | .13, .18* | 27.5 | 217 | Do. |
| 1050-F... | 77,500 | 101,000 | 22.5 | 43.3 | .21, .24* | 28.0 | 196 | Fine silky. |
| 1250-F... | 66,000 | 96,000 | 26.0 | 49.1 | .34*, .18 | 24.0 | 179 | Fine silky; cup shaped. |
| 1450-F... | 60,500 | 95,000 | 26.0 | 49.1 | .36*, .16 | 27.0 | 170 | Fine silky. |
| 1550-F... | 51,000 | 93,000 | 25.0 | 43.3 | .34*, .16 | 23.0 | 170 | Silky. |
| 1650-F... | 53,500 | 96,000 | 24.0 | 43.3 | .31*, .17 | 23.0 | 170 | Silky; trace of granulation. |
| 1450-18... | 64,000 | 97,500 | 21.0 | 27.4 | .15, .27* | 25.0 | 179 | Silky. |
| 1450-19.. | 79,000 | 126,500 | 7.0 | 9.5 | .08*, .06 | 34.0 | 228 | Fine granular, silky spot at circumference. |
| Ingot-18. | 51,500 | 91,000 | 7.0 | 9.5 | .07, .07* | 25.0 | 187 | Granular, with dark colored spot at circumference. |
| Ingot-19 . | 64,500 | 99,500 | 4.5 | 5.7 | .03, .06* | 31.0 | 228 | Granular, silvery luster. |
| Ingot-16 . | 34,000 | 72,000 | 7.5 | 9.5 | .08*, .07* | 23.0 | 149 | Do. |
| 1450-17... | 47,000 | 88,500 | 25.0 | 43.3 | .19, .31* | 25.0 | 166 | Dull silky. |
| Ingot-17 . | 50,500 | 86,000 | 9.0 | 9.5 | .10*, .08 | 24.0 | 163 | Fine granular; amorphous spot at circumference. |
| 1450-20... | 89,500 | 140,500 | 6.0 | 9.5 | .07*, .05 | 38.5 | 269 | Fine granular. |
| Ingot-20 . | 72,500 | 109,500 | 3.5 | 1.8 | .03, .04 | 32.0 | 248 | Granular; silvery luster. |
| 1450-21... | 87,000 | 120,000 | 20.0 | 49.1 | .30*, .10 | 36.0 | 241 | Fine silky. |
| Ingot-21 . | 65,000 | 88,000 | 2.0 | 1.8 | .03*, .01 | 34.5 | 207 | Granular; silvery luster. |
| 1450-22... | 67,500 | 96,500 | 28.0 | 62.3 | .41*, .15 | 28.0 | 187 | Fine silky; serrated. |
| Ingot-22 . | 62,000 | 88,500 | 8.0 | 20.5 | .05, .11* | 27.0 | 179 | Amorphous, 90 per cent; granular, 10 per cent. |
| 1450-23... | 61,500 | 91,500 | 28.5 | 49.1 | .28*, .29* | 25.0 | 179 | Fine silky. |
| Ingot-23 . | 52,000 | 88,000 | 10.0 | 13.3 | .12*, .08 | 26.0 | 179 | Granular; silvery luster. |
| 1450-24... | 61,000 | 91,500 | 24.5 | 43.3 | .25*, .24* | 23.5 | 170 | Fine silky. |
| Ingot-24 . | 50,000 | 83,000 | 10.0 | 16.9 | .07, .13* | 23.5 | 170 | Amorphous; trace of granulation. |
| 1450 F-25. | 44,000 | 91,500 | 25.0 | 37.2 | .17, .33* | 27.0 | 163 | Dull silky, 70 per cent; granular, 30 per cent. |
| Ingot-25 . | 42,000 | 82,000 | 6.5 | 5.7 | .07*, .06 | 25.5 | 159 | Granular, dark-colored spot at circumference. |
| 1450-26... | 45,000 | 84,000 | 30.0 | 54.6 | .42*, .18 | 25.0 | 149 | Dull silky; cup shaped. |
| Ingot-26 . | 46,000 | 82,000 | 25.5 | 34.0 | .32*, .19 | 25.5 | 159 | Dull silky. |
| S.O..... | 58,000 | 93,500 | 15.0 | 24.0 | .18*, .12 | 22.5 | 163 | Dull silky, with light spot at circumference. |
| S.O.F.... | 54,000 | 87,000 | 25.5 | 40.3 | .17, .34* | 23.0 | 163 | Silky. |
| S.O.A.... | 44,500 | 88,500 | 24.5 | 37.2 | .28*, .21* | 24.0 | 166 | Do. |
| S.O.A-1.. | 54,000 | 99,000 | 23.0 | 40.3 | .20, .26* | 25.0 | 183 | Silky trace of granulation. |
| S.O.A-2.. | 68,500 | 115,500 | 17.5 | 40.3 | .15, .20* | 30.5 | 228 | Silky. |
| S.O.A-3.. | 47,000 | 88,000 | 25.0 | 43.3 | .32*, .18 | 24.0 | 166 | Do. |

## *FORGED STEEL RECEIVED ON PURCHASE ORDERS.*

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *P. ct.* | *P. ct.* | *In.* *In.* | | | |
| P. O. 9425-$\frac{1}{2}$ | ..... | 49,500 | 68,500 | 35.0 | 64.6 | 0.44*, 0.26 | 27.0 | ..... | Fine silky. |
| P. O. 9425-2$\frac{11}{16}$ | ..... | 49,500 | 74,000 | 29.5 | 51.9 | .35*, .24 | 28.0 | ..... | Do. |
| P. O. 8484-11 D. M. | ..... | 48,000 | 112,500 | 20.0 | 37.1 | .20*, .20* | 31.0 | ..... | Silky, 20 per cent; fine granular, 80 per cent. |
| P. O. 9072-2$\frac{1}{2}$ | 3 | 51,000 | 95,000 | 25.0 | 40.3 | .18, .32* | 29.0 | ..... | Fine silky. |
| P. O. 9424-1$\frac{1}{2}$ | ..... | 63,000 | 94,500 | 27.0 | 51.9 | .19, .35* | 29.0 | ..... | Do. |
| P. O. 9424-1$\frac{1}{2}$ | ..... | 60,500 | 106,000 | 22.0 | 37.1 | .20, .24* | 30.0 | ..... | Silky. |
| P. O. 9424-2$\frac{1}{2}$ | ..... | 53,500 | 99,500 | 23.0 | 40.3 | .31*, .15 | 29.0 | ..... | Do. |
| P. O. 9915-1$\frac{1}{2}$ | 3 | 51,500 | 105,000 | 23.0 | 46.2 | .32*, .14 | ..... | ..... | Do. |
| P. O. 9915-2$\frac{1}{2}$ | 3 | 42,500 | 93,500 | 24.0 | 37.1 | .20, .28* | ..... | ..... | Silky; trace of granulation. |
| P. O. 689..... | 3 | 70,000 | 117,000 | 22.5 | 49.1 | .28*, .17 | 32.0 | ..... | Fine silky. |
| P. O. 1420.... | 2 | 36,000 | 83,500 | 20.0 | 27.4 | .14, .26* | 26.5 | 166 | Dull silky; trace of granulation. |
| P. O. 1420.... | 3 | 33,900 | 58,800 | 32.5 | 62.7 | .24, .49* | 17.5 | 90 | Fine silky. |
| P. O. 1093-2.. | 2 | 70,500 | 111,000 | 22.5 | 49.1 | .14, .31* | 28.0 | 202 | Do. |
| P. O. 1420.... | 2 | 37,000 | 89,500 | 17.0 | 16.9 | .20*, .14 | 27.0 | 163 | Fine granular, amorphous spot at circumference. |
| P. O. 1420.... | 2 | 33,500 | 58,500 | 38.0 | 62.3 | .50*, .26 | 20.0 | 105 | Fine silky. |
| P. O. 1702.... | ..... | 50,500 | 99,500 | 21.5 | 40.3 | .13, .30* | 27.0 | 179 | Dull silky. |
| P. O. 2043.... | 3 | 54,000 | 104,500 | 18.5 | 37.2 | .10, .27* | 29.0 | 202 | Dull silky; trace of granulation. |
| P. O. 2557-3.. | 3 | 53,500 | 97,500 | 24.5 | 43.3 | .31, .18 | 26.5 | 179 | Silky. |

[Inch section in which fracture occurred marked thus *.]

# BRONZE FOR ORDNANCE WORK.

## *BRONZE FROM WATERTOWN ARSENAL FOUNDRY.*

[The inch in which fracture occurred is marked thus,*.]

| Marks. | Grade. | Tensile strength. | Elongation. | Contraction. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Shore scleroscope. | Brinell. | |
| | | *Lbs. per sq. in.* | *P. ct.* | *P. ct.* | *In. In.* | | | |
| 746 | 3 | 44,400 | 10.0 | 11.6 | 0.06, 0.14* | 22.5 | ..... | Light and lemon yellow. |
| 762 | 4 | 63,400 | 28.0 | 31.6 | .25, .31* | 31.0 | ..... | Light yellow. |
| 769 | 4 | 65,400 | 27.0 | 29.5 | .26, .28* | 22.0 | ..... | Do. |
| 770 | 3 | 61,800 | 27.0 | 29.5 | .24, .30* | 21.0 | ..... | Do. |
| 782 | 3 | 61,800 | 24.5 | 27.4 | .22, .27* | 22.5 | ..... | Do. |
| 811 | 3 | 60,200 | 22.0 | 29.4 | .18, .26* | 22.0 | ..... | Do. |
| 825 | 3 | 60,200 | 16.0 | 20.8 | .14, .18* | 23.0 | ..... | Do. |
| 838 | 3 | 64,000 | 23.0 | 25.2 | .20, .26* | 32.5 | ..... | Do. |
| 844 | 3 | 60,600 | 40.0 | 39.6 | .41, .39 | 20.0 | ..... | Do. |
| 849 | 3 | 60,200 | 40.0 | 37.7 | .45, .35 | 20.0 | ..... | Do. |
| 856 | 3 | 62,400 | 22.5 | 18.6 | .25*, .20 | 26.0 | ..... | Do. |
| 861 | 3 | 61,400 | 21.0 | 23.0 | .18, .24* | 23.0 | ..... | Do. |
| 868 | 3 | 64,200 | 19.5 | 18.6 | .17, .22* | 25.0 | ..... | Do. |
| 869 | 3 | 61,200 | 21.0 | 23.0 | .24*, .18 | 25.0 | ..... | Do. |
| 872 | 3 | 62,600 | 23.0 | 25.2 | .26*, .20 | 24.0 | ..... | Do. |
| 873 | 3 | 64,400 | 23.0 | 25.2 | .25*, .21 | 26.0 | ..... | Do. |
| 874 | 3 | 62,200 | 20.0 | 18.6 | .23*, .17 | 24.0 | ..... | Do. |
| 889 | 3 | 62,000 | 25.0 | 27.4 | .29*, .21 | 24.0 | ..... | Do. |
| 902 | 4 | 63,600 | 26.0 | 29.5 | .26*, .26* | 24.0 | ..... | Do. |
| 909 | 3 | 58,000 | 10.0 | 16.3 | .10*, .10* | 27.0 | ..... | Light yellow; silvery spot at circumference. |
| 930 | 3 | 64,600 | 15.0 | 18.6 | .15, .15 | 28.0 | ..... | Light yellow. |
| 933 | 3 | 64,800 | 29.0 | 27.4 | .32*, .26 | 24.0 | ..... | Do. |
| 945 | 3 | 64,000 | 13.0 | 18.6 | .14*, .12 | 28.0 | ..... | Do. |
| 948 | 3 | 63,800 | 17.5 | 23.0 | .15, .20* | 27.0 | ..... | Do. |
| 951 | 3 | 63,200 | 16.0 | 23.0 | .18, .14 | 28.0 | ..... | Do. |
| 954 | 3 | 62,200 | 24.5 | 25.2 | .22, .27* | 23.0 | ..... | Do. |
| 967 | 3 | 59,200 | 21.5 | 27.4 | .17, .26* | 23.0 | ..... | Light yellow and lavender. |
| 970 | 3 | 62,000 | 18.0 | 20.8 | .21*, .15 | 23.5 | ..... | Light yellow. |
| 972 | 3 | 56,600 | 12.5 | 18.6 | .09, .16* | 27.0 | ..... | Do. |
| 988 | 3 | 62,540 | 22.5 | 20.9 | .19, .26* | 21.0 | ..... | Do. |
| 1005 | 3 | 59,410 | 17.5 | 16.5 | .14, .21* | 21.0 | ..... | Do. |
| 1013 | 3 | 63,330 | 25.5 | 27.5 | .23, .28* | 21.5 | ..... | Do. |
| 1019 | 3 | 62,060 | 15.5 | 20.8 | .17*, .14 | 22.0 | ..... | Do. |
| 1025 | 3 | 65,690 | 27.5 | 27.4 | .25*, .30* | 22.0 | ..... | Do. |
| 1031 | 3 | 60,600 | 14.0 | 14.0 | .12, .16* | 32.0 | ..... | Do. |
| 1038 | 3 | 55,800 | 15.0 | 18.6 | .17*, .13 | 26.0 | ..... | Light yellow; two blowholes $\frac{1}{8}$ inch diameter near circumference. |
| 1041 | 4 | 65,000 | 25.0 | 27.4 | .23, .27* | 27.0 | ..... | Light yellow. |
| 1045 | 3 | 59,200 | 13.5 | 16.3 | .15*, .12 | 29.0 | ..... | Do. |
| 1050 | 3 | 48,400 | 12.5 | 11.6 | .15*, .10 | 26.0 | ..... | Light yellow and lavender. |
| 1058 | 3 | 61,400 | 13.0 | 16.3 | .14*, .12 | 27.5 | ..... | Light yellow. |
| 1062 | 4 | 67,200 | 35.0 | 33.6 | .38*, .32 | 26.0 | ..... | Do. |
| 1063 | 3 | 59,800 | 17.5 | 20.8 | .15, .20* | 27.0 | ..... | Light yellow and lavender. |
| 1070 | 3 | 57,800 | 16.5 | 14.0 | .19*, .14 | 27.0 | ..... | Light yellow. |
| 1076 | 3 | 62,400 | 18.5 | 20.8 | .16, .21* | 26.0 | ..... | Do. |
| 1081 | 3 | 62,200 | 20.0 | 20.8 | .18, .22* | 25.0 | ..... | Do. |
| 1088 | 3 | 57,200 | 23.5 | 18.6 | .19*, .28* | 23.0 | ..... | Light yellow and lavender. |
| 1094 | 3 | 55,800 | 12.5 | 16.3 | .14*, .11 | 27.0 | ..... | Light yellow and lavender; white spot $\frac{1}{16}$ inch diameter at circumference. |
| 1100 | 3 | 57,800 | 15.0 | 18.6 | .13, .17* | 26.0 | ..... | Do. |
| 1109 | 3 | 47,400 | 8.0 | 16.3 | .08*, .08* | 25.0 | ..... | Light yellow and lavender; white spot $\frac{1}{8}$ inch diameter at circumference. |
| 1116 | 3 | 43,400 | 10.0 | 11.6 | .07, .13* | 23.0 | ..... | Light yellow and golden yellow. |
| | | 46,600 | 12.5 | 16.3 | .10, .15* | 22.0 | ..... | Do. |
| 1121 | 3 | 59,200 | 12.5 | 14.0 | .14*, .11 | 25.0 | ..... | Light yellow and lavender. |
| 1130 | 3 | 61,400 | 12.0 | 16.3 | .14*, .10 | 25.0 | ..... | Do. |
| 1135 | 3 | 46,200 | 11.0 | 11.6 | .07, .15* | 23.0 | ..... | Golden yellow and lavender. |
| 1145 | 3 | 62,200 | 23.0 | 23.0 | .23*, .23* | 23.5 | ..... | Light yellow and lavender. |
| 1150 | 3 | 58,800 | 13.5 | 14.0 | .15, .13 | 22.0 | ..... | Do. |
| 1157 | 3 | 59,000 | 15.0 | 16.3 | .13, .17* | 23.5 | ..... | Light yellow. |
| 1159 | 3 | 63,000 | 22.0 | 20.8 | .21, .23* | 24.5 | ..... | Do. |
| 1169 | 3 | 60,400 | 17.0 | 18.6 | .16, .18* | 23.0 | ..... | Do. |

*Bronze from Watertown Arsenal foundry*—Continued.

| Marks. | Grade. | Tensile strength. | Elongation. | Contraction. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Shore scleroscope. | Brinell. | |
| | | *Lbs. per sq. in.* | *P. ct.* | *P. ct.* | *In. In.* | | | |
| 1177 | 3 | 57,800 | 13.0 | 16.3 | 0.13*, 0.13 | 23.0 | ..... | Light yellow and lavender. |
| 1187 | 3 | 62,200 | 16.5 | 14.0 | .18, .15 | ..... | ..... | Light yellow. |
| 1195 | 3 | 58,000 | 21.0 | 18.6 | .26, .16 | ..... | ..... | Do. |
| 1205 | 3 | 60,600 | 20.0 | 16.4 | .22, .18 | ..... | ..... | Do. |
| 1210 | 3 | 59,200 | 18.0 | 20.8 | .18*, .18* | ..... | ..... | Light yellow and lavender. |
| 1215 | 3 | 50,200 | 3.0 | 3.4 | .04*, .02 | ..... | ..... | Light yellow and golden; Coarse grained. |
| 1267 | 3 | 60,600 | 17.0 | 18.6 | .16, .18 | ..... | ..... | Light yellow. |
| 1315 | 3 | 58,400 | 14.0 | 14.0 | .16, .12 | ..... | ..... | Do. |
| 1320 | 3 | 63,000 | 17.0 | 16.3 | .19, .15 | ..... | ..... | Do. |
| 1324 | 3 | 58,200 | 13.0 | 16.4 | .11, .15* | ..... | ..... | Light yellow and lavender. |
| 1329 | 3 | 55,800 | 9.0 | 11.6 | .11*, .08 | ..... | ..... | Do. |
| 1341 | 3 | 39,400 | 7.5 | 6.7 | .09*, .06 | ..... | ..... | Light brown, golden yellow spots. |
| | | 60,400 | 15.5 | 18.6 | .18*, .13 | ..... | ..... | Light yellow. |
| 1343 | 3 | 55,800 | 10.5 | 11.6 | .12*, .09 | ..... | ..... | Light yellow and lavender. |
| 1355 | 3 | 59,200 | 13.5 | 14.0 | .11, .16* | ..... | ..... | Do. |
| 1361 | 3 | 60,000 | 21.5 | 18.6 | .23, .20 | ..... | ..... | Light yellow. |
| 1379 | 3 | 56,200 | 13.5 | 16.4 | .15*, .12 | ..... | ..... | Do. |
| 1385 | 3 | 58,600 | 19.0 | 18.6 | .21*, .17 | ..... | ..... | Light yellow and lavender. |
| 1393 | 3 | 52,800 | 5.0 | 6.7 | .07*, .03 | ..... | ..... | Light yellow. |
| 1404 | 3 | 62,800 | 20.5 | 23.0 | .22*, .19 | ..... | ..... | Do. |
| 1422 | 3 | 54,600 | 12.0 | 14.0 | .09, .15* | ..... | ..... | Light yellow and lavender. |
| 1436 | 4 | 63,600 | 22.0 | 23.0 | .24*, .20 | ..... | ..... | Uniform light yellow. |
| 1454 | 3 | 62,800 | 21.0 | 23.0 | .23*, .19 | ..... | ..... | Light yellow and lavender. |
| 1464 | 3 | 44,000 | 9.5 | 11.6 | .11*, .08 | ..... | ..... | Light yellow and lemon yellow. |
| 1467 | 4 | 64,200 | 38.5 | 33.6 | .41*, .36 | ..... | ..... | Uniform light yellow. |
| 1487 | 4 | 66,000 | 36.5 | 35.7 | .39*, .34 | ..... | ..... | Do. |
| 1497 | 3 | 45,000 | 11.5 | 11.6 | .14*, .09 | ..... | ..... | Lavender and lemon yellow. |
| 1499 | 4 | 64,800 | 38.0 | 35.7 | .37, .39 | ..... | ..... | Uniform light yellow. |
| 1531 | 3 | 54,200 | 14.5 | 16.3 | .18*, .11 | ..... | ..... | Light yellow and lavender. |
| 1543 | 4 | 64,400 | 35.0 | 31.6 | .36*, .34 | ..... | ..... | Light yellow. |
| 1551 | 4 | 65,000 | 36.5 | 31.6 | .40*, .33 | ..... | ..... | Do. |
| 1560 | 4 | 64,200 | 26.0 | 25.2 | .23, .29* | ..... | ..... | Light yellow, golden yellow spots. |
| 1571 | 4 | 64,000 | 32.5 | 29.5 | .36*, .29 | ..... | ..... | Light yellow. |
| 1579 | 4 | 66,400 | 19.0 | 20.8 | .16, .22* | ..... | ..... | Light yellow, golden yellow spots. |
| 1582 | 4 | 64,200 | 37.5 | 33.6 | .37*, .38* | ..... | ..... | Light yellow. |
| 1590 | 4 | 65,000 | 39.0 | 37.1 | .36, .42* | ..... | ..... | Do. |
| 1593 | 4 | 66,800 | 36.5 | 31.6 | .37, .36* | ..... | ..... | Do. |
| 1598 | 4 | 63,400 | 34.5 | 31.6 | .34, .35* | ..... | ..... | Light yellow, silvery spot near circumference. |
| 1613 | 4 | 63,600 | 43.0 | 39.6 | .44*, .42* | ..... | ..... | Light yellow. |
| 1632 | 4 | 64,000 | 36.0 | 31.6 | .37*, .35 | ..... | ..... | Do. |
| 1670 | 4 | 67,200 | 29.0 | 29.5 | .31*, .27 | ..... | ..... | Do. |
| 1682 | 4 | 64,000 | 40.0 | 31.6 | .37, .43* | ..... | ..... | Do. |
| 1714 | 4 | 65,400 | 40.5 | 37.7 | .43*, .38* | ..... | ..... | Do. |
| 1737 | 4 | 64,000 | 40.5 | 37.7 | .38, .43* | ..... | ..... | Do. |
| 1751 | 4 | 66,800 | 38.0 | 35.7 | .36, .40* | ..... | ..... | Do. |
| 1764 | 4 | 63,400 | 35.0 | 35.7 | .35*, .35* | ..... | ..... | Do. |
| 1772 | 3 | 63,400 | 21.0 | 20.8 | .21*, .21* | ..... | ..... | Do. |
| 1817 | 4 | 66,800 | 40.0 | 35.7 | .40*, .40* | ..... | ..... | Uniform light yellow. |
| 1832 | 3 | 60,400 | 21.5 | 23.0 | .23*, .20 | ..... | ..... | Light yellow and lavender. |
| 1842 | 3 | 60,200 | 20.5 | 20.8 | .23*, .18 | ..... | ..... | Do. |
| 1849 | 3 | 64,000 | 17.0 | 18.6 | .18*, .16 | ..... | ..... | Light yellow. |
| 1860 | 3 | 66,000 | 23.0 | 18.6 | .25*, .21 | ..... | ..... | Do. |
| 1888 | 4 | 64,400 | 36.0 | 31.6 | .35*, .37* | ..... | ..... | Do. |
| 1889 | 3 | 63,600 | 21.0 | 25.1 | .23*, .19 | ..... | ..... | Do. |
| 1932 | 3 | 64,400 | 20.5 | 23.0 | .24*, .17 | ..... | ..... | Light yellow and lavender. |
| 1980 | 3 | 59,000 | 12.0 | 17.9 | .09, .15* | ..... | ..... | Do. |
| 2021 | 3 | 59,200 | 30.5 | 27.4 | .31*, .30 | ..... | ..... | Do. |
| 2039 | 4 | 63,800 | 40.0 | 37.7 | .42*, .38 | 23.0 | ..... | Light yellow. |
| 2044 | 3 | 61,000 | 42.5 | 37.7 | .42*, .43* | 24.0 | ..... | Do. |
| 2069 | 4 | 64,000 | 30.5 | 25.2 | .29, .32* | 24.0 | ..... | Light yellow and lavender. |
| 2080 | 3 | 62,800 | 35.0 | 35.7 | .33, .37* | 22.0 | ..... | Light yellow. |
| 2095 | 4 | 68,200 | 33.0 | 29.5 | .30, .33* | 22.0 | ..... | Do. |
| 2107 | 4 | 69,000 | 37.0 | 35.6 | .37*, .37* | 26.0 | ..... | Do. |
| 2117 | 3 | 63,000 | 28.5 | 27.3 | .26, .31* | 21.0 | ..... | Do. |
| 2125 | 3 | 60,400 | 30.0 | 27.3 | .26, .34* | 22.0 | ..... | Do. |
| 2143 | 3 | 60,200 | 21.0 | 23.0 | .25*, .17 | 24.0 | ..... | Light yellow and lavender. |
| 2170 | 4 | 66,800 | 31.5 | 29.5 | .33*, .30 | 24.0 | ..... | Light yellow. |
| 2176 | 3 | 56,400 | 25.0 | 23.0 | .29*, .21 | 21.0 | ..... | Do. |

*Bronze from Watertown Arsenal foundry*—Continued.

| Marks. | Grade. | Tensile strength. | Elongation. | Contraction. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Shore scleroscope. | Brinell. | |
| | | *Lbs. per sq. in.* | *P. ct.* | *P. ct.* | *In. In.* | | | |
| 2197 | 4 | 59,300 | 20.0 | 25.2 | 0.22*, 0.18 | ..... | ..... | Light yellow. |
| | | 61,000 | 24.0 | 27.4 | .27*, .21 | 21.0 | ..... | Do. |
| 2245 | 4 | 65,300 | 41.5 | 37.7 | .42*, .41 | ..... | ..... | Do. |
| 2257 | 4 | 54,800 | 18.5 | 23.0 | .22*, .15 | 2.30 | ..... | Do. |
| | | 43,600 | 12.5 | 14.0 | .18*, .07 | 23.0 | ..... | Light yellow and lemon yellow. |
| | | 64,000 | 33.5 | 33.8 | .28, .39* | 28.0 | ..... | Light yellow. |
| 2266 | 4 | 65,700 | 36.0 | 33.6 | .27, .45* | ..... | ..... | Do. |
| 2275 | 3 | 64,000 | 22.0 | 23.0 | .24*, .20 | 23.0 | ..... | Do. |
| 2284 | 3 | 61,800 | 26.0 | 23.0 | .29*, .23 | 20.0 | ..... | Light yellow oblique. |
| 2293 | 3 | 64,800 | 34.0 | 29.5 | .35*, .33 | 20.0 | ..... | Light yellow. |
| 2300 | 3 | 63,200 | 20.0 | 23.0 | .18, .22* | 22.0 | ..... | Do. |
| 2347 | 4 | 64,200 | 41.0 | 37.7 | .39, .43* | 21.0 | ..... | Light yellow oblique. |
| 2385 | 4 | 67,200 | 36.5 | 35.7 | .39*, .34 | 22.0 | ..... | Light yellow. |
| 2426 | 4 | 62,400 | 44.0 | 39.6 | .43, .45* | 22.0 | ..... | Do. |
| 2431 | 4 | 65,200 | 38.5 | 33.8 | .45*, .32 | 20.0 | ..... | Light yellow oblique. |
| 2472 | 3 | 64,600 | 29.5 | 25.2 | .32*, .27 | 22.0 | ..... | Light yellow. |
| 2476 | 3 | 60,800 | 15.0 | 14.0 | .19*, .11 | 22.0 | ..... | Light yellow and lavender. |
| 2478 | 3 | 65,800 | 24.5 | 23.0 | .23, .26* | 22.5 | ..... | Light yellow. |
| 2483 | 4 | 64,400 | 39.5 | 35.7 | .37, .42* | 21.0 | ..... | Do. |
| 2520 | 4 | 66,800 | 36.0 | 31.6 | .40*, .32 | 22.0 | ..... | Do. |
| 2521 | 3 | 62,800 | 25.5 | 25.2 | .23, .28* | 21.0 | ..... | Do. |
| 2559 | 3 | 63,400 | 21.5 | 23.0 | .20, .23* | 22.0 | ..... | Light yellow and lavender. |
| 2589 | 4 | 64,800 | 39.5 | 33.8 | .36, .43* | 21.0 | ..... | Light yellow oblique. |
| 2590 | 4 | 67,600 | 31.5 | 31.6 | .30, .33* | 26.0 | ..... | Light yellow. |
| 2594 | 4 | 66,800 | 34.5 | 33.8 | .32, .37* | 24.0 | ..... | Do. |
| 2595 | 4 | 73,800 | 25.0 | 25.2 | .21, .29* | 31.0 | ..... | Do. |
| 2596 | 4 | 61,400 | 41.0 | 37.7 | .45*, .37 | 30.0 | ..... | Do. |
| 2597 | 4 | 66,400 | 38.5 | 37.7 | .38, .39* | 31.0 | ..... | Do. |
| 2600 | 4 | 66,400 | 30.5 | 29.5 | .27, .34* | 30.0 | ..... | Do. |
| 2601 | 4 | 68,200 | 34.0 | 33.8 | .29, .39* | 31.0 | ..... | Do. |
| 2603 | 4 | 67,600 | 22.5 | 25.2 | .25*, .20 | 32.0 | ..... | Do. |
| 2604 | 4 | 67,800 | 16.5 | 18.6 | .14, .19* | 24.0 | ..... | Do. |
| 2605 | 4 | 61,200 | 10.5 | 14.0 | .09, .12* | 23.0 | ..... | Do. |
| | | 68,200 | 21.0 | 23.0 | .21*, .21* | 29.0 | ..... | Do. |
| 2606 | 4 | 64,600 | 17.5 | 16.3 | .18*, .17 | 23.0 | ..... | Do. |
| 2611 | 4 | 71,600 | 26.0 | 25.2 | .26*, .26* | 30.0 | ..... | Do. |
| 2612 | 4 | 65,200 | 28.0 | 29.5 | .29*, .27 | 27.0 | ..... | Do. |
| 2614 | 3 | 60,800 | 20.5 | 20.8 | .18, .23* | 26.0 | ..... | Do. |
| 2679 | 4 | 64,600 | 34.5 | 33.8 | .38*, .31 | 33.0 | ..... | Do. |
| 2681 | 4 | 69,200 | 20.5 | 23.0 | .20*, .21* | 28.0 | ..... | Do. |
| 2682 | 4 | 65,800 | 32.5 | 31.6 | .28, .37* | 26.0 | ..... | Do. |
| 2683 | 4 | 71,600 | 19.5 | 20.8 | .20*, .19 | 26.0 | ..... | Do. |
| 2686 | 4 | 68,600 | 30.0 | 27.4 | .28*, .22 | 24.0 | ..... | Do. |
| 2687 | 4 | 71,400 | 29.0 | 29.5 | .30*, .28* | 27.0 | ..... | Do. |
| 2693 | 4 | 68,600 | 30.5 | 27.4 | .31*, .30 | 29.0 | ..... | Do. |
| 2694 | 4 | 69,000 | 29.5 | 27.4 | .31*, .28* | 28.0 | ..... | Do. |
| 2695 | 4 | 70,200 | 22.0 | 23.0 | .22*, .22* | 26.0 | ..... | Do. |
| 2698 | 4 | 67,000 | 26.5 | 25.2 | .29*, .24 | 24.0 | ..... | Do. |
| 2699 | 4 | 67,400 | 30.0 | 29.5 | .33*, .27 | 24.5 | ..... | Do. |
| 2700 | 4 | 71,200 | 25.0 | 25.2 | .27*, .23 | 29.5 | ..... | Do. |
| 2703 | 4 | 67,200 | 20.5 | 20.8 | .22*, .19 | 27.0 | ..... | Do. |
| 2704 | 4 | 69,000 | 19.0 | 20.8 | .18, .20* | 27.0 | ..... | Do. |
| 2705 | 4 | 68,600 | 26.0 | 23.0 | .38*, .14 | 28.0 | ..... | Do. |
| 2706 | 4 | 70,600 | 21.0 | 23.0 | .21*, .21* | 28.0 | ..... | Do. |
| 2707 | 4 | 63,800 | 17.5 | 14.0 | .18, .17 | 29.0 | ..... | Do. |
| 2708 | 4 | 64,600 | 29.5 | 27.4 | .30*, .29* | 27.5 | ..... | Do. |
| 2710 | 3 | 58,000 | 17.5 | 17.8 | .16, .19* | 25.0 | ..... | Do. |
| 2779 | 4 | 62,000 | 18.0 | 20.1 | .20*, .16 | 27.0 | ..... | Do. |
| 2780 | 4 | 63,400 | 25.5 | 22.4 | .26*, .27* | 26.5 | ..... | Do. |
| 2781 | 4 | 61,600 | 21.0 | 23.0 | .21*, .21* | 21.0 | ..... | Light yellow and lemon yellow. |
| 2782 | 4 | 67,400 | 27.5 | 27.4 | .28*, .27* | 22.0 | ..... | Light yellow. |
| 2785 | 4 | 63,600 | 28.0 | 27.4 | .26, .30* | 21.0 | ..... | Do. |
| 2786 | 4 | 64,400 | 24.0 | 25.2 | .24*, .24* | 21.0 | ..... | Do. |
| 2787 | 3 | 62,000 | 29.5 | 27.4 | .32*, .27 | 20.5 | ..... | Light yellow oblique. |
| 2861 | 4 | 65,600 | 34.0 | 31.6 | .34*, .34* | 21.0 | ..... | Light yellow. |
| 2862 | 4 | 57,000 | 13.0 | 16.3 | .16*, .10 | 22.0 | ..... | Do. |
| | | 68,800 | 24.0 | 24.0 | .21, .27* | 25.0 | ..... | Do. |
| 2863 | 4 | 63,800 | 19.5 | 20.8 | .19*, .19* | 23.0 | ..... | Do. |
| 2864 | 4 | 52,600 | 17.0 | 18.6 | .19*, .15 | 21.0 | ..... | Light yellow and lemon yellow. |
| | | 62,800 | 29.5 | 27.4 | .28, .31* | 20.0 | ..... | Light yellow. |

*Bronze from Watertown Arsenal foundry*—Continued.

| Marks. | Grade. | Tensile strength. | Elongation. | Contraction. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Shore scleroscope. | Brinell. | |
| | | *Lbs. per sq. in.* | *P. ct.* | *P. ct.* | *In. In.* | | | |
| 2865 | 4 | 50,500 | 8.0 | 16.9 | 0.09*, 0.07 | 21.0 | ..... | Light yellow and lemon yellow spot at circumference. |
| | | 56,200 | 13.5 | 16.3 | .13, .14* | 21.0 | ..... | Light yellow. |
| | | 64,400 | 24.0 | 24.1 | .22, .26* | 25.0 | ..... | Do. |
| 2866 | 4 | 65,400 | 26.5 | 25.2 | .24, .29* | 23.0 | ..... | Do. |
| 2867 | 4 | 64,000 | 31.5 | 29.5 | .29, .34* | 28.5 | ..... | Do. |
| 2868 | 4 | 63,400 | 26.5 | 25.2 | .24, .29* | 23.0 | ..... | Do. |
| 2869 | 4 | 67,200 | 26.5 | 27.4 | .25, .28* | 24.0 | ..... | Do. |
| 2870 | 4 | 68,400 | 29.0 | 29.5 | .26, .32* | 23.5 | ..... | Do. |
| 2871 | 4 | 63,200 | 25.0 | 25.2 | .23, .27* | 28.0 | ..... | Do. |
| 2872 | 4 | 64,600 | 31.0 | 29.5 | .33*, .29 | 30.5 | ..... | Do. |
| 2873 | 4 | 64,600 | 27.0 | 25.2 | .28*, .26 | 23.5 | ..... | Do. |
| 2874 | 4 | 56,400 | 17.5 | 18.6 | .16, .19* | 20.5 | ..... | Light yellow and lemon yellow. |
| 2875 | 3 | 60,600 | 7.5 | 11.6 | .08*, .07 | 29.0 | ..... | Light yellow. |
| 2940 | 4 | 53,800 | 17.0 | 16.9 | .14, .20* | 21.5 | ..... | Light yellow and lavender. |
| 2941 | 4 | 51,800 | 13.0 | 16.0 | .15*, .11 | 24.0 | ..... | Do. |
| 2942 | 4 | 60,200 | 18.0 | 18.0 | .20*, .16 | 24.0 | ..... | Do. |
| 2943 | 4 | 63,600 | 30.5 | 28.0 | .32*, .29 | 23.5 | ..... | Light yellow. |
| 2944 | 4 | 62,600 | 29.0 | 26.0 | .27, .31* | 23.0 | ..... | Do. |
| 2945 | 4 | 59,600 | 20.5 | 18.0 | .22*, .19 | 22.5 | ..... | Light yellow and lavender. |
| 2946 | 4 | 61,000 | 32.0 | 27.6 | .30, .34* | 23.0 | ..... | Light yellow. |
| 2947 | 4 | 65,800 | 29.5 | 24.0 | .28, .31* | 23.0 | ..... | Do. |
| 2948 | 4 | 62,200 | 39.5 | 33.8 | .40*, .39* | 23.0 | ..... | Do. |
| 2949 | 4 | 62,400 | 37.5 | 31.6 | .40*, .35 | 22.0 | ..... | Do. |
| 2970 | 4 | 61,000 | 26.0 | 27.4 | .29*, .23 | 23.0 | ..... | Do. |
| 2971 | 4 | 65,000 | 37.0 | 33.8 | .34, .40* | 22.0 | ..... | Do. |
| 2972 | 4 | 64,500 | 31.0 | 30.7 | .29, .33* | 18.5 | ..... | Do. |
| 2973 | 4 | 59,000 | 25.5 | 21.0 | .25, .26* | 24.0 | ..... | Light yellow, golden yellow spots. |
| 2974 | 4 | 63,400 | 31.5 | 25.4 | .29, .34* | 23.0 | ..... | Light yellow. |
| 2975 | 4 | 63,600 | 39.0 | 37.8 | .38, .40* | 25.0 | ..... | Do. |
| 2976 | 4 | 62,600 | 41.5 | 39.8 | .41*, .42* | 25.0 | ..... | Do. |
| 2977 | 4 | 63,800 | 33.5 | 29.6 | .35*, .32 | 22.0 | ..... | Do. |
| 2978 | 4 | 63,800 | 28.5 | 25.4 | .30*, .27 | 22.5 | ..... | Do. |
| 2979 | 3 | 59,000 | 13.5 | 18.0 | .12, .15* | 24.0 | ..... | Light yellow and lavender. |
| 3039 | 4 | 61,600 | 24.5 | 26.0 | .26*, .23 | 24.5 | 116 | Light yellow. |
| 3040 | 4 | 64,200 | 29.5 | 28.0 | .32*, .27 | 26.0 | 116 | Do. |
| 3041 | 4 | 63,800 | 36.0 | 31.6 | .38*, .34 | 24.5 | 116 | Do. |
| 3042 | 3 | 58,600 | 15.0 | 18.0 | .14, .16* | 25.0 | 118 | Do. |
| 3096 | 3 | 56,600 | 9.5 | 14.0 | .07, .12* | 27.0 | 118 | Light yellow and lavender. |
| 3104 | 3 | 58,000 | 8.0 | 9.5 | .07, .09* | 22.0 | 121 | Light yellow. |
| 3162 | 3 | 58,200 | 20.0 | 24.0 | .22*, .18 | 23.5 | 103 | Light yellow and lavender. |
| 3216 | 3 | 59,400 | 22.0 | 24.0 | .19, .25* | 23.0 | 103 | Do. |
| 3236 | 3 | 57,800 | 11.0 | 14.0 | .13*, .09 | 25.0 | 126 | Do. |
| 3294 | 3 | 57,400 | 14.0 | 14.0 | .17*, .11 | 23.0 | 126 | Do. |
| 3317 | 3 | 58,200 | 19.5 | 24.0 | .19, .20* | 24.0 | 105 | Do. |
| 3325 | 3 | 57,200 | 13.0 | 14.0 | .15*, .11 | 23.5 | 121 | Do. |
| 3351 | 3 | 59,600 | 15.5 | 16.0 | .18*, .13 | 21.5 | 112 | Do. |
| 3403 | 3 | 65,200 | 18.0 | 20.8 | .15, .21* | 25.0 | 116 | Do. |
| 3428 | 3 | 61,200 | 16.0 | 18.6 | .17*, .15* | 24.0 | 128 | Do. |
| 3456 | 3 | 65,200 | 26.0 | 24.0 | .28*, .24 | 23.0 | 124 | Do. |
| 3514 | 3 | 57,000 | 15.0 | 18.0 | .14*, .16* | 22.0 | 121 | Do. |
| 3534 | 3 | 60,600 | 18.0 | 18.6 | .17, .19* | 20.5 | 124 | Light yellow. |
| 3556 | 3 | 58,800 | 10.0 | 11.6 | .12*, .08 | 21.5 | 131 | Light yellow and lavender. |
| 3576 | 3 | 58,800 | 12.5 | 11.6 | .08, .17* | 22.0 | 128 | Do. |
| 3602 | 3 | 62,200 | 20.5 | 20.8 | .22*, .19 | 20.0 | 121 | Light yellow. |
| 3647 | 3 | 59,400 | 14.0 | 11.6 | .13, .15 | 21.0 | 116 | Light yellow and lavender. |
| 3671 | 3 | 61,000 | 15.0 | 18.6 | .16*, .14 | 21.5 | 121 | Light yellow. |
| 3697 | 3 | 65,000 | 18.0 | 18.6 | .19*, .17 | 21.0 | 128 | Do. |
| 3722 | 3 | 61,000 | 15.0 | 14.0 | .13, .17* | 23.5 | 126 | Light yellow and lavender. |
| 3744 | 3 | 60,600 | 16.5 | 20.8 | .19*, .14 | 22.0 | 121 | Light yellow. |
| 3766 | 4 | 64,400 | 35.5 | 31.6 | .40*, .31 | 21.0 | 118 | Do. |
| 3770 | 4 | 63,600 | 35.5 | 31.6 | .39, .32 | 21.0 | 109 | Do. |
| 3773 | 4 | 60,400 | 49.5 | 45.3 | .49*, .50* | 19.0 | 107 | Uniform light yellow. |
| 3789 | 4 | 61,800 | 46.0 | 41.6 | .51*, .41 | 20.5 | 109 | Do. |
| 3798 | 3 | 61,000 | 16.5 | 20.8 | .19*, .14 | 26.0 | 126 | Light yellow and lavender. |
| 3801 | 3 | 64,800 | 28.5 | 27.4 | .30*, .27 | 22.0 | 121 | Do. |
| 3810 | 4 | 61,000 | 46.5 | 43.5 | .43*, .50* | 17.5 | 109 | Uniform light yellow. |
| 3826 | 4 | 60,800 | 21.0 | 27.4 | .23*, .19 | 22.0 | 116 | Light yellow with golden yellow spots. |
| 3827 | 3 | 56,800 | 19.5 | 25.2 | .17, .22* | 21.5 | 112 | Light yellow. |
| 3839 | 4 | 61,800 | 46.5 | 45.3 | .48*, .45* | 20.5 | 109 | Light yellow oblique. |

*Bronze from Watertown Arsenal foundry*—Continued.

| Marks. | Grade. | Tensile strength. | Elongation. | Contraction. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Shore scleroscope. | Brinell. | |
| | | *Lbs. per sq. in.* | *P. ct.* | *P. ct.* | *In. In.* | | | |
| 3849 | 3 | 67,400 | 27.5 | 25.2 | 0.29*, 0.26 | 21.5 | 121 | Light yellow. |
| 3854 | 4 | 61,400 | 49.0 | 45.3 | .47*, .51* | 19.5 | 103 | Light yellow oblique. |
| 3860 | 4 | 62,600 | 47.5 | 45.3 | .48, .47 | 19.0 | 103 | Uniform light yellow. |
| 3865 | 4 | 62,400 | 46.0 | 45.3 | .43, .49* | 19.5 | 107 | Do. |
| 3867 | 4 | 62,800 | 45.0 | 41.6 | .46*, .44 | 19.5 | 107 | Light yellow oblique. |
| 3873 | 4 | 63,600 | 44.5 | 39.6 | .45*, .44* | 20.0 | 103 | Light yellow. |
| 3879 | 4 | 64,000 | 47.0 | 47.2 | .46*, .48* | 20.5 | 107 | Do. |
| 3885 | 4 | 63,400 | 48.5 | 49.0 | .43, .54 | 20.5 | 107 | Do. |
| 3891 | 3 | 60,400 | 15.5 | 16.3 | .18*, .13 | 22.0 | 116 | Light yellow and lavender. |
| 3897 | 4 | 64,400 | 45.0 | 43.5 | .46*, .44* | 20.5 | 107 | Light yellow. |
| 3901 | 4 | 62,200 | 49.5 | 49.0 | .58*, .41 | 20.0 | 107 | Do. |
| 3905 | 4 | 65,400 | 42.5 | 39.6 | .42*, .43* | 21.0 | 112 | Light yellow oblique. |
| 3910 | 4 | 63,800 | 42.0 | 27.4 | .40*, .44* | 21.0 | 105 | Do. |
| 3912 | 4 | 61,600 | 46.0 | 41.6 | .42, .50* | 21.0 | 103 | Do. |
| 3916 | 4 | 63,800 | 44.0 | 39.6 | .44*, .44* | 21.0 | 107 | Do. |
| 3920 | 3 | 60,000 | 17.0 | 18.6 | .16, .18* | 20.5 | 116 | Light yellow and lavender. |
| 3931 | 4 | 63,800 | 45.5 | 41.6 | .52*, .39 | 20.5 | 103 | Light yellow oblique. |
| 3934 | 4 | 64,400 | 45.0 | 47.2 | .48*, .42 | 21.0 | 109 | Light yellow. |
| 3939 | 4 | 64,400 | 42.5 | 41.6 | .40, .45* | 21.0 | 112 | Light yellow oblique. |
| 3944 | 4 | 64,200 | 43.5 | 39.6 | .45*, .42 | 21.0 | 107 | Light yellow. |
| 3948 | 4 | 65,000 | 41.0 | 35.7 | .44*, .38 | 21.5 | 112 | Do. |
| 3953 | 4 | 64,800 | 42.5 | 41.6 | .44*, .21 | 21.0 | 109 | Light yellow oblique. |
| 3959 | 4 | 64,000 | 45.0 | 41.6 | .41, .49* | 22.5 | 107 | Light yellow. |
| 3962 | 4 | 64,000 | 43.5 | 33.8 | .43*, .44* | 21.0 | 107 | Light yellow oblique. |
| 3966 | 4 | 61,600 | 50.0 | 49.0 | .42, .48* | 21.0 | 103 | Do. |
| 3968 | 4 | 66,600 | 42.5 | 35.7 | .38, .47* | 21.0 | 114 | Do. |
| 3972 | 4 | 65,000 | 44.0 | 45.3 | .43*, .45* | 23.5 | 112 | Light yellow. |
| 3974 | 4 | 62,800 | 49.0 | 47.2 | .47*, .50* | 23.5 | 103 | Do. |
| 3977 | 4 | 64,400 | 45.0 | 45.3 | .44*, .46* | 21.0 | 99 | Do. |
| 3981 | 4 | 66,000 | 44.0 | 45.3 | .40, .48* | 21.5 | 112 | Do. |
| 3983 | 4 | 64,400 | 45.0 | 47.2 | .47,* .43 | 25.0 | 107 | Do. |
| 3985 | 4 | 66,800 | 44.0 | 45.3 | .44*, .44* | 26.0 | 114 | |
| 3989 | 4 | 63,200 | 47.0 | 47.2 | .49*, .45 | 25.5 | 107 | Do. |
| 3991 | 4 | 66,800 | 41.0 | 39.6 | .40, .42* | 26.0 | 112 | Do. |
| 3993 | 4 | 65,000 | 44.5 | 39.6 | .50*, .39 | 23.0 | 112 | Do. |
| 3997 | 4 | 63,000 | 46.0 | 39.6 | .50*, .42 | 23.0 | 107 | Light yellow oblique. |
| 3999 | 4 | 64,200 | 43.5 | 39.6 | .48*, .39 | 23.0 | 107 | Do. |
| 4002 | 4 | 65,400 | 34.0 | 31.6 | .38*, .30 | 22.0 | 112 | Light yellow. |
| 4006 | 4 | 62,600 | 48.5 | 45.3 | .50*, .47* | 22.0 | 107 | Light yellow oblique. |
| 4008 | 4 | 65,600 | 45.0 | 41.6 | .47*, .43* | 22.0 | 112 | Do. |
| 4011 | 4 | 64,800 | 45.0 | 41.6 | .43, .47* | 22.0 | 116 | Do. |
| 4015 | 4 | 61,600 | 46.5 | 39.6 | .47*, .46* | 21.0 | 107 | Do. |
| 4018 | 4 | 65,200 | 47.0 | 45.3 | .47*, .47* | 21.5 | 116 | Light yellow. |
| 4025 | 4 | 63,600 | 47.5 | 45.3 | .48,* .47* | 21.0 | 112 | Light yellow oblique. |
| 4029 | 4 | 63,000 | 50.0 | 50.7 | .45, .55* | 20.0 | 107 | Light yellow. |
| 4033 | 3 | 70,000 | 17.0 | 16.3 | .20,* .14 | 24.0 | 131 | Do. |
| 4061 | 3 | 65,800 | 18.0 | 18.6 | .16, .20* | 23.0 | 116 | Light yellow and lavender. |
| 4069 | 3 | 63,800 | 17.5 | 20.8 | .16, .19* | 24.0 | 131 | Do. |
| 4099 | 4 | 65,400 | 34.0 | 27.4 | .34, .34* | 21.0 | 116 | Light yellow. |
| 4101 | 4 | 65,200 | 44.5 | 39.6 | .41, .48* | 23.0 | 116 | Light yellow oblique. |
| 4104 | 3 | 63,400 | 12.0 | 14.0 | .12*, .12 | 26.0 | 131 | Light yellow. |
| 4141 | 4 | 63,200 | 39.5 | 31.6 | .35, .44* | 25.0 | 112 | Uniform light yellow. |
| 4145 | 3 | 64,600 | 26.0 | 27.4 | .30*, .22 | 24.0 | 126 | Light yellow. |
| 4152 | 4 | 64,200 | 44.0 | 39.6 | .41*, .47* | 21.0 | 112 | Do. |
| 4169 | 4 | 64,600 | 44.5 | 39.6 | .44*, .45* | 20.0 | 112 | Do. |
| 4187 | 3 | 67,200 | 13.5 | 16.3 | .15*, .12* | 22.0 | 131 | Do. |
| 4218 | 4 | 65,800 | 42.5 | 39.6 | .42, .43* | 21.0 | 114 | Do. |
| 4244 | 4 | 64,000 | 46.2 | 47.2 | .49*, .43 | 22.0 | 116 | Light yellow oblique. |
| 4251 | 3 | 66,800 | 23.5 | 25.2 | .26*, .21 | 25.5 | 131 | Light yellow. |
| 4284 | 3 | 65,800 | 23.0 | 25.2 | .20, .26* | 23.0 | 126 | Do. |
| 4301 | 4 | 64,200 | 44.0 | 42.7 | .46*, .42 | 22.0 | 112 | Light yellow oblique. |
| 4308 | 4 | 69,200 | 38.0 | 35.7 | .38*, .38* | 22.0 | 121 | Do. |
| 4317 | 4 | 63,800 | 44.5 | 41.6 | .46*, .43* | 21.0 | 112 | Light yellow. |
| 4324 | 3 | 68,800 | 23.0 | 25.2 | .26*, .20 | 21.0 | 131 | Do. |
| 4354 | 4 | 66,600 | 41.0 | 37.7 | .39, .43* | 21.0 | 118 | Light yellow oblique. |
| 4357 | 4 | 64,200 | 45.0 | 41.6 | .42, .48* | 21.0 | 112 | Do. |
| 4372 | 3 | 65,200 | 29.5 | 25.2 | .27, .32* | 23.0 | 121 | Light yellow. |
| 4444 | 4 | 63,600 | 47.0 | 43.5 | .47*, .47* | 22.5 | 116 | Do. |
| 4460 | 4 | 64,000 | 39.5 | 31.6 | .45*, .34 | 22.5 | 107 | Do. |
| 4484 | 4 | 63,200 | 48.0 | 47.2 | .49*, .47* | 22.0 | 112 | Do. |
| 4500 | 4 | 62,200 | 49.5 | 49.0 | .57*, .42 | 23.0 | 107 | Do. |
| 4516 | 3 | 64,600 | 21.0 | 23.0 | .18, .24* | 23.0 | 121 | Do. |
| 4522 | 3 | 65,400 | 21.0 | 20.8 | .20, .22* | 24.0 | 124 | Light yellow and lavender. |
| 4528 | 4 | 62,200 | 50.5 | 50.7 | .55*, .46* | 20.0 | 105 | Light yellow. |

*Bronze from Watertown Arsenal foundry*—Continued.

| Marks. | Grade. | Tensile strength. | Elongation. | Contraction. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Shore scleroscope. | Brinell. | |
| | | *Lbs. per sq. in.* | *P. ct.* | *P. ct.* | *In. In.* | | | |
| 4538 | 4 | 62,800 | 44.5 | 39.6 | 0.49*, 0.40 | 26.0 | 109 | Light yellow. |
| 4550 | 4 | 64,000 | 40.0 | 35.7 | .44*, .36 | 20.0 | 112 | Light yellow oblique. |
| 4561 | 4 | 63,000 | 49.0 | 50.7 | .53*, .45 | 20.0 | 112 | Do. |
| 4575 | 4 | 62,860 | 47.0 | 45.3 | .49*, .45* | 20.0 | 103 | Do. |
| 4585 | 4 | 62,200 | 49.5 | 52.5 | .51*, .48* | 20.5 | 107 | Do. |
| 4600 | 4 | 62,800 | 46.0 | 45.3 | .45*, .47* | 20.0 | 107 | Do. |
| 4613 | 4 | 63,400 | 46.0 | 47.2 | .48*, .44* | 20.0 | 107 | Do. |
| 4645 | 4 | 63,200 | 46.0 | 47.2 | .48*, .44* | 20.0 | 105 | Do. |
| 4665 | 4 | 63,200 | 43.5 | 43.5 | .38, .49* | 20.0 | 112 | Do. |
| 4680 | 4 | 60,000 | 21.5 | 25.2 | .17, .26* | 20.5 | 112 | Light yellow with three golden yellow spots. |
| 4681 | 4 | 62,200 | 48.0 | 47.2 | .48*, .48* | 19.5 | 107 | Light yellow oblique. |
| 4683 | 4 | 62,000 | 48.0 | 45.3 | .47*, .49* | 19.0 | 107 | Do. |
| 4705 | 4 | 62,800 | 45.0 | 43.5 | .44*, .46* | 19.0 | 112 | Do. |
| 4720 | 4 | 62,600 | 48.0 | 47.2 | .47*, .49* | 20.5 | 107 | Do. |
| 4732 | 3 | 60,000 | 43.0 | 41.6 | .51*, .35 | 19.0 | 97 | Light yellow. |
| 4742 | 3 | 59,200 | 38.5 | 35.7 | .38, .39* | 18.5 | 99 | Do. |
| 4749 | 3 | 69,000 | 29.5 | 27.4 | .30*, .29* | 22.0 | 126 | Do. |
| 4771 | 3 | 63,600 | 15.0 | 20.8 | .13, .17* | 23.0 | 121 | Light yellow and lavender. |
| 4781 | 3, 4 | 68,200 | 28.0 | 25.2 | .30*, .26 | 22.5 | 121 | Light yellow. |
| 4801 | 3 | 64,600 | 28.5 | 27.4 | .28*, .29* | 22.5 | 116 | Do. |
| 4810 | 3 | 65,200 | 21.5 | 25.2 | .23*, .20 | 22.0 | 121 | Do. |
| 4821 | 4 | 61,000 | 46.0 | 41.6 | .48*, .44 | 18.5 | 103 | Do. |
| 4825 | 4 | 60,600 | 49.0 | 45.3 | .53, .45 | 22.0 | 101 | Do. |
| 4831 | 4 | 62,200 | 49.5 | 50.7 | .45, .54 | 21.0 | 107 | Do. |
| 4843 | 4 | 60,600 | 42.0 | 37.7 | .41*, .43* | 19.0 | 107 | Do. |
| 4845 | 3 | 58,500 | 13.0 | 20.5 | .15*, .11 | 17.5 | 118 | Do. |
| 4857 | 4 | 60,200 | 44.5 | 41.6 | .44*, .45* | 20.5 | 103 | Light yellow oblique. |
| 4859 | 3 | 64,000 | 23.0 | 24.0 | .26*, .20 | 17.5 | 116 | Light yellow. |
| 4884 | 4 | 62,500 | 41.5 | 46.2 | .46*, .37 | 17.0 | 103 | Do. |
| 4886 | 3 | 66,000 | 22.5 | 25.2 | .20, .25* | 21.0 | 126 | Light yellow and lavender. |
| 4904 | 4 | 33,000 | 2.5 | 14.0 | .02, .03 | 18.0 | 103 | Light yellow and golden yellow. |
| | 4 | 35,600 | 13.5 | 26.3 | .03, .24* | 18.0 | 94 | Do. |
| | 4 | 49,500 | 18.5 | 27.4 | .20*, .17 | 16.5 | 95 | Do. |
| | 4 | 61,000 | 44.0 | 43.3 | .33, .55* | 18.0 | 103 | Light yellow. |
| 4906 | 4 | 64,200 | 45.0 | 45.3 | .45*, .45* | 19.5 | 112 | Light yellow oblique. |
| 4908 | 4 | 62,600 | 45.5 | 43.5 | .45*, .46* | 20.0 | 109 | Do. |
| 4984 | 4 | 63,000 | 44.5 | 41.6 | .47*, .42 | 20.0 | 109 | Do. |
| 5074 | 4 | 64,200 | 44.5 | 39.6 | .42*, .47* | 20.0 | 112 | Do. |
| 5098 | 4 | 63,400 | 40.5 | 35.7 | .36, .45* | 20.5 | 109 | Do. |
| 5105 | 4 | 64,700 | 45.5 | 45.2 | .44, .47* | 20.0 | 112 | Do. |
| 5154 | 4 | 63,200 | 46.0 | 43.5 | .45*, .47* | 29.5 | 112 | Do. |
| 5161 | 4 | 63,400 | 47.0 | 45.3 | .54*, .40 | 20.0 | 112 | Light yellow. |
| 5168 | 4 | 63,000 | 40.0 | 35.7 | .41*, .39* | 19.0 | 109 | Light yellow oblique. |
| 5175 | 4 | 61,600 | 49.5 | 52.5 | .49*, .50* | 18.0 | 103 | Light yellow. |
| 5177 | 4 | 66,400 | 37.5 | 33.8 | .40*, .35 | 20.5 | 116 | Light yellow oblique. |
| 5179 | 4 | 62,000 | 42.5 | 43.5 | .42*, .43* | 24.0 | 103 | Do. |
| 5182 | 4 | 57,600 | 52.0 | 54.2 | .60*, .44 | 24.0 | 99 | Light yellow. |
| 5245 | 4 | 60,600 | 41.5 | 39.6 | .45*, .38 | 24.5 | 103 | Do. |
| 5273 | 4 | 62,400 | 43.5 | 39.6 | .48*, .39 | 27.0 | 109 | Light yellow oblique. |
| 5283 | 4 | 60,400 | 45.5 | 41.6 | .50*, .41 | 27.0 | 105 | Do. |
| 5286 | 4 | 62,800 | 45.0 | 43.5 | .43*, .47* | 26.0 | 109 | Light yellow. |
| 5325 | 4 | 62,000 | 43.5 | 39.6 | .41, .46* | 23.0 | 105 | Light yellow oblique. |
| 5392 | 4 | 62,000 | 44.5 | 39.6 | .45*, .44 | 28.0 | 107 | Do. |
| 5428 | 4 | 63,000 | 43.5 | 39.6 | .47*, .40 | 27.0 | 105 | Light yellow. |
| 5466 | 4 | 63,600 | 40.0 | 39.6 | .42*, .38 | 24.0 | 112 | Do. |
| 5469 | 4 | 61,000 | 43.5 | 39.6 | .41, .46* | 22.0 | 105 | Light yellow oblique. |
| 5471 | 4 | 61,200 | 41.5 | 39.6 | .48*, .35 | 22.0 | 103 | Light yellow. |
| 5474 | 4 | 60,400 | 45.0 | 41.6 | .45*, .45* | 23.0 | 103 | Light yellow oblique. |
| 5484 | 4 | 60,000 | 44.5 | 41.6 | .53*, .36 | 22.0 | 97 | Do. |
| 5491 | 4 | 61,600 | 47.5 | 45.3 | .48*, .47* | 23.0 | 99 | Light yellow. |
| 5499 | 3 | 63,800 | 14.5 | 18.6 | .17*, .12 | 22.0 | 121 | Light yellow and lavender. |
| 5531 | 3 | 68,400 | 17.5 | 18.6 | .18*, .17* | 22.5 | 126 | Do. |
| 5551 | 3 | 64,200 | 17.5 | 16.3 | .19*, .16 | 21.0 | 126 | Light yellow. |
| 5571 | 4 | 59,600 | 45.0 | 43.5 | .38, .52* | 19.0 | 95 | Do. |
| 5578 | 4 | 67,800 | 10.5 | 11.6 | .09, .12* | 32.0 | 149 | Golden yellow oblique. |
| 5583 | 4 | 60,800 | 47.0 | 43.5 | .49*, .45* | 20.0 | 103 | Light yellow. |
| 5589 | 3 | 65,400 | 23.0 | 23.0 | .20, .26* | 22.0 | 124 | Do. |
| 5609 | 4 | 62,200 | 41.0 | 37.7 | .37, .45* | 21.0 | 107 | Light yellow oblique. |
| 5648 | 3 | 64,000 | 25.5 | 25.2 | .23, .28* | 22.0 | 126 | Light yellow. |
| 5665 | 2, 3, 4 | 66,600 | 25.0 | 20.5 | .29*, .21 | 24.0 | 126 | Do. |
| 5676 | 4 | 60,000 | 46.0 | 43.5 | .46*, .46* | 20.5 | 103 | Light yellow oblique. |

*BRONZES RECEIVED ON PURCHASE ORDERS, AND EXPENDITURE ORDERS.*

| Marks. | Grade. | Tensile strength per square inch. | Elongation. | Contraction. | Elongation of inch sections. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *P. ct.* | *P. ct.* | *In. In.* | | | |
| P. O. 9283.... | Tobin..... | 68,500 | 32.5 | 49.1 | 0.33*, 0.32* | 28.0 | ..... | Uniform light yellow, silky. |
| P. O. 9331.... | ...do..... | 69,200 | 32.5 | 39.6 | .35*, .30 | 29.0 | ..... | Do. |
| P. B. T. D. 110. | Phosphor bronze. | 24,000 | 6.5 | 5.7 | .06*, .05 | 15.0 | ..... | Yellow, brown, and lavender. |
| P. O. 9494.... | Tobin..... | 65,500 | 35.0 | 54.6 | .45*, .25 | 29.0 | ..... | Yellow, silky. |
| P. O. 389..... | ...do..... | 62,800 | 30.5 | 26.0 | .30*, .31* | ..... | ..... | Light yellow. |
| P. O. 191..... | ...do..... | 70,000 | 29.0 | 49.1 | .29*, .30* | ..... | ..... | Light yellow, silky. |
| C. P. O. 933.. | ...do..... | 54,200 | 44.5 | 49.0 | 44, .45* | 22.0 | ..... | Do. |
| P. O. 1126.... | ...do..... | 74,500 | 20.5 | 49.5 | .13, .28* | 33.5 | ..... | Light yellow. |
| P. O. 1270.... | Tobin 1½.. | 64,200 | 32.0 | 56.1 | .41*, .23 | 27.0 | ..... | Do. |
| P. O. 1270.... | Tobin 1$\frac{11}{16}$. | 61,200 | 35.0 | 37.8 | .28, .42* | 25.5 | ..... | Light yellow, circular seam around center. |
| P. O. 1126.... | Tobin..... | 63,000 | 37.0 | 49.1 | .28, .46* | 26.5 | 124 | Light yellow, cup-shaped. |
| P. O. 1901.... | ...do..... | 55,800 | 44.0 | 41.6 | .37, .51* | 25.0 | 103 | Uniform light yellow, oblique. |
| P. O. 2259.... | ...do..... | 61,000 | 37.5 | 39.6 | .38*, .37* | 25.5 | 118 | Uniform light yellow. |
| P. O. 2259-1.. | ...do..... | 66,000 | 24.0 | 62.0 | .34*, .14 | 27.0 | 131 | Uniform light yellow, long. Seam in center. |
| P. O. 2259-2.. | ...do..... | 65,000 | 26.5 | 58.0 | .39*, .20 | 25.0 | 126 | Uniform light yellow. |
| P. O. 2342.... | ...do..... | 57,200 | 31.5 | 29.5 | .33*, .20 | 24.0 | 107 | Do. |
| P. O. 1901.... | ...do..... | 57,000 | 48.0 | 49.1 | .55*, .41 | 17.0 | 92 | Uniform light yellow, oblique. |
| | | 57,500 | 46.5 | 54.6 | .56*, .37 | 17.0 | 90 | Do. |
| Ex. O. 7975 | ..... | 60,600 | 13.5 | 13.2 | .14, .13 | 30.0 | ..... | Golden yellow. |
| X-7477-A.... | ..... | 62,400 | 34.0 | 31.6 | .33, .35* | 19.0 | 107 | Light yellow. |
| X-7477-B.... | ..... | 19,600 | 1.5 | 2.0 | .03*, 0. | 20.0 | 101 | Silvery gray and golden yellow. |
| X-7477-C.... | ..... | 15,800 | 2.0 | 2.0 | .04*, 0. | 12.0 | 80 | Do. |
| 1260F..... | Tobin..... | 60,000 | 11.0 | 13.2 | .09, .13* | 20.0 | ..... | Light yellow, seam crossing through fracture. |
| | | 56,000 | 12.0 | 17.0 | .11, .13* | 19.0 | ..... | Light yellow, with 5 seams parallel to axis. |
| 1357F..... | ...do..... | 68,500 | 31.0 | 40.3 | .25, .37* | 22.0 | ..... | Light yellow. |
| 1358F..... | ...do..... | 69,500 | 33.0 | 40.3 | .41*, .25 | 24.0 | ..... | Do. |
| 1359F..... | ...do..... | 72,500 | 32.0 | 30.7 | .32*, .32* | 23.5 | ..... | Do. |
| 222F..... | ...do..... | 67,500 | 30.0 | 30.7 | .27, .33* | 19.5 | 121 | Do. |
| 478..... | ...do..... | 70,000 | 42.0 | 51.9 | .40*, .35 | 20.0 | 121 | Do. |

# CAST IRON FOR ORDNANCE WORK.

## *CAST IRON FROM WATERTOWN ARSENAL FOUNDRY.*

| Marks. | Grade. | Tensile strength per square inch. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|
| | | | Shore sclero-scope. | Brinell appa-ratus. | |
| | | *Lb.* | | | |
| 3504 | 2 | 24,400 | 33.5 | ..... | Fine granular gray. |
| | | 26,400 | 33.0 | ..... | Do. |
| | | 30,400 | ..... | ..... | Do. |
| | | 30,200 | ..... | ..... | Do. |
| 3520 | 2 | 29,800 | 36.0 | ..... | Do. |
| | | 27,800 | 36.0 | ..... | Do. |
| 3521 | 2 | 27,200 | 34.0 | ..... | Do. |
| 3527 | 2 | 27,500 | 35.0 | ..... | Fine granular gray, fracture in neck. |
| 3529 | 2 | 31,600 | 34.0 | ..... | Fine granular gray. |
| | | 28,800 | 34.0 | ..... | Do. |
| 3530 | 2 | 31,600 | 35.0 | ..... | Do. |
| | | 32,800 | 33.0 | ..... | Do. |
| 3535 | 2 | 30,300 | 37.0 | ..... | Fine granular gray, fracture in neck. |
| 3536 | 2 | 30,000 | 34.0 | ..... | Fine granular gray. |
| | | 30,600 | 33.0 | ..... | Do. |
| 3537 | 2 | 32,600 | 35.0 | ..... | Do. |
| | | 30,000 | 36.0 | ..... | Do. |
| 3539 | 2 | 32,200 | 32.0 | ..... | Fine granular gray, fracture in neck. |
| 3540 | 2 | 24,400 | 36.0 | ..... | Fine granular gray. |
| | | 27,600 | 33.0 | ..... | Do. |
| | | 29,000 | ..... | ..... | Do. |
| | | 28,500 | ..... | ..... | Do. |
| 3559 | 2 | 32,800 | ..... | ..... | Do. |
| 3560 | 2 | 30,200 | ..... | ..... | Do. |
| | | 32,400 | ..... | ..... | Do. |
| 3585 | 2 | 29,200 | ..... | ..... | Do. |
| 3586 | 2 | 29,800 | ..... | ..... | Do. |
| | | 29,400 | ..... | ..... | Do. |
| 3587 | 2 | 30,800 | ..... | ..... | Fine granular gray, fracture in neck. |
| | | 29,600 | ..... | ..... | Do. |
| 3611 | 2 | 22,500 | ..... | ..... | Gray granular, brown spongy over half cross-section. |
| | | 31,000 | ..... | ..... | Fine granular gray. |
| 3612 | 2 | 25,200 | ..... | ..... | Do. |
| | | 27,000 | ..... | ..... | Do. |
| | | 28,500 | ..... | ..... | Do. |
| | | 28,400 | ..... | ..... | Do. |
| 3613 | 2 | 30,600 | ..... | ..... | Fine granular gray, fracture in neck. |
| | | 30,000 | ..... | ..... | Do. |
| 3614 | 2 | 30,600 | ..... | ..... | Do. |
| | | 30,800 | ..... | ..... | Do. |
| 3669 | 2 | 29,800 | ..... | ..... | Gray granular. |
| 3670 | 2 | 32,800 | ..... | ..... | Fine granular gray, fracture in neck. |
| | | 33,000 | ..... | ..... | Do. |
| 3671 | 2 | 31,000 | ..... | ..... | Fine granular gray. |
| | | 30,000 | ..... | ..... | Do. |
| 3683 | 2 | 33,600 | ..... | ..... | Do. |
| 3684 | 2 | 28,000 | ..... | ..... | Do. |
| | | 28,200 | ..... | ..... | Do. |
| 3685 | 2 | 28,200 | ..... | ..... | Do. |
| | | 26,600 | ..... | ..... | Do. |
| 3691 | 2 | 30,000 | ..... | ..... | Do. |
| 3692 | 2 | 27,200 | ..... | ..... | Granular gray. |
| | | 26,800 | ..... | ..... | Do. |
| | | 27,400 | 33.0 | ..... | Fine granular gray. |
| | | 30,200 | 33.5 | ..... | Do. |
| 3693 | 2 | 31,800 | ..... | ..... | Do. |
| | | 29,000 | ..... | ..... | Do. |
| 3701 | 2 | 32,300 | 36.0 | ..... | Do. |
| 3702 | 2 | 28,800 | ..... | ..... | Do. |
| | | 27,200 | ..... | ..... | Do. |
| | | 27,600 | 36.0 | ..... | Do. |
| | | 26,400 | 36.0 | ..... | Do. |

*Cast iron from Watertown Arsenal foundry*—Continued.

| Marks. | Grade. | Tensile strength per square inch. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|
| | | | Shore scleroscope. | Brinell apparatus. | |
| | | *Lb.* | | | |
| 3703 | 2 | 31,000 | 36.0 | ..... | Fine granular gray. |
| | | 27,600 | 33.0 | ..... | Do. |
| 3709 | 2 | 30,600 | 39.0 | ..... | Do. |
| 3710 | 2 | 32,000 | 35.0 | ..... | Do. |
| | | 31,200 | 36.0 | ..... | Do. |
| 3711 | 2 | 31,600 | 34.0 | ..... | Do. |
| | | 32,200 | 35.0 | ..... | Do. |
| 3715 | 2 | 33,000 | 33.0 | ..... | Do. |
| 3716 | 2 | 32,400 | 34.0 | ..... | Do. |
| | | 31,400 | 33.0 | ..... | Do. |
| 3726 | 2 | 25,600 | 31.0 | ..... | Do. |
| 3727 | 2 | 27,400 | 33.0 | 179 | Do. |
| 3728 | 2 | 27,600 | 34.0 | 174 | Do. |
| 3736 | 2 | 36,600 | 38.0 | ..... | Do. |
| 3737 | 2 | 29,200 | 33.0 | ..... | Do. |
| | | 28,600 | 34.0 | ..... | Do. |
| 3750 | 2 | 30,000 | 35.0 | ..... | Do. |
| 3751 | 2 | 32,600 | 35.0 | ..... | Do. |
| | | 32,800 | 35.0 | ..... | Do. |
| 3757 | 2 | 30,100 | 34.0 | ..... | Do. |
| 3759 | 2 | 30,600 | 36.0 | ..... | Do. |
| | | 30,400 | 36.0 | ..... | Do. |
| 3761 | 2 | 31,400 | 31.0 | ..... | Do. |
| 3762 | 2 | 27,500 | ..... | ..... | Do. |
| | | 29,700 | ..... | ..... | Do. |
| 3775 | 2 | 29,200 | 34.0 | ..... | Do. |
| 3776 | 2 | 31,600 | ..... | ..... | Do. |
| | | 32,000 | ..... | ..... | Do. |
| 3790 | 2 | 32,300 | 32.0 | ..... | Do. |
| 3791 | 2 | 30,200 | 33.0 | ..... | Do. |
| | | 30,800 | 34.0 | ..... | Do. |
| 3810 | 2 | 32,700 | 33.0 | ..... | Do. |
| 3811 | 2 | 29,400 | 33.0 | ..... | Do. |
| | | 29,000 | 34.0 | ..... | Do. |
| 3813 | 2 | 33,400 | 32.0 | ..... | Do. |
| 3814 | 2 | 29,800 | 32.5 | ..... | Do. |
| | | 29,800 | 33.0 | ..... | Do. |
| 3826 | 2 | 32,100 | 34.0 | ..... | Do. |
| 3827 | 2 | 32,400 | 36.0 | ..... | Do. |
| | | 32,000 | 35.0 | ..... | Do. |
| 3832 | 2 | 33,400 | 33.0 | ..... | Do. |
| 3833 | 2 | 30,000 | 32.0 | ..... | Do. |
| | | 29,800 | 34.0 | ..... | Do. |
| 3838 | 2 | 31,300 | 33.0 | ..... | Do. |
| 3839 | 2 | 32,600 | 34.0 | ..... | Do. |
| 3843 | 2 | 32,000 | 35.0 | ..... | Do. |
| 3844 | 2 | 31,200 | 35.0 | ..... | Do. |
| | | 34,800 | 35.0 | ..... | Do. |
| 3850 | ..... | 33,300 | 34.5 | 187 | Do. |
| 3851 | 1,2 | 32,600 | 35.0 | 183 | Do. |
| | | 31,000 | 34.0 | 183 | Do. |
| 3864 | 2 | 32,600 | 33.0 | 183 | Do. |
| 3865 | 2 | 29,400 | 33.0 | 189 | Do. |
| | | 31,200 | 32.0 | 189 | Do. |
| 3873 | 2 | 32,400 | 34.0 | 147 | Do. |
| 3874 | 2 | 30,800 | 38.0 | 192 | Do. |
| | | 30,000 | 37.0 | 183 | Do. |
| 3880 | 2 | 31,400 | 35.0 | 187 | Do. |
| 3881 | 2 | 30,000 | 33.5 | 187 | Do. |
| | | 30,200 | 35.0 | 187 | Do. |
| 3883 | 2 | 33,800 | 35.0 | 170 | Do. |
| 3884 | 2 | 30,200 | 34.0 | 170 | Do. |
| | | 29,600 | 34.0 | 174 | Do. |
| 3890 | 2 | 29,500 | 31.0 | 156 | Do. |
| 3891 | | 24,800 | 33.0 | 163 | Fine granular dark gray. |
| | | 28,400 | 33.0 | 179 | Fine granular gray. |
| | | 25,600 | 32.5 | 159 | Do. |
| | | 29,000 | 33.0 | 179 | Do. |
| | | 24,400 | 31.0 | 156 | Fine granular dark gray. |
| | | 27,800 | 31.5 | 170 | Do. |
| 3924 | 2 | 31,500 | 36.0 | 170 | Fine granular gray. |
| 3949 | 2 | 31,500 | 32.0 | 170 | Do. |
| 3957 | 2 | 28,400 | 31.5 | 156 | Do. |
| 3962 | 2 | 27,100 | 30.0 | 170 | Do. |

*Cast iron from Watertown Arsenal foundry*—Continued.

| Marks. | Grade. | Tensile strength per square inch. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|
| | | | Shore scleroscope. | Brinell apparatus. | |
| | | *Lb.* | | | |
| 3963 | 2 | 24,800 | 32.0 | 170 | Fine granular gray. |
| | | 25,000 | 31.5 | 163 | Do. |
| | | 25,800 | 32.0 | 163 | Do. |
| | | 25,000 | 32.0 | 163 | Do. |
| 3969 | 2 | 26,700 | 30.0 | 163 | Do. |
| 3976 | 2 | 32,300 | 35.0 | 179 | Do. |
| 3977 | 2 | 26,500 | 31.0 | 170 | Do. |
| 3978 | 2 | 31,600 | 30.0 | 170 | Do. |
| | | 30,400 | 33.8 | 170 | Do. |
| 4013 | 1,2 | 27,400 | 34.0 | 187 | Do. |
| 4014 | 2 | 29,700 | 31.0 | 166 | Do. |
| 4015 | 2 | 24,400 | 32.5 | 170 | Do. |
| | | 25,500 | 33.0 | 174 | Do. |
| | | 28,400 | 24.0 | 159 | Do. |
| | | 30,000 | 28.0 | 159 | Do. |
| 4016 | 2 | 26,400 | 33.0 | 170 | Do. |
| | | 28,800 | 33.5 | 179 | Do. |
| 4022 | 2 | 29,800 | 32.0 | 183 | Do. |
| | | 28,600 | 30.0 | 170 | Do. |
| 4023 | 2 | 29,400 | 31.0 | 179 | Do. |
| | | 20,000 | 30.0 | 179 | Do. |
| 4024 | 2 | 24,400 | 29.0 | 174 | Do. |
| | | 28,000 | 29.5 | 179 | Do. |
| | | 23,600 | 30.0 | 166 | Do. |
| 4028 | 1 | 17,800 | 25.0 | 179 | Fine granular dark gray. |
| | 1 | 18,000 | 27.0 | 131 | Fine granular gray. |
| 4029 | 2 | 22,600 | 30.0 | 174 | Do. |
| | | 27,400 | 32.0 | 179 | Do. |
| 4033 | 2 | 28,400 | 34.0 | 179 | Do. |
| 4037 | 2 | 28,800 | 30.0 | 174 | Do. |
| | | 33,000 | 30.0 | 170 | Do. |
| 4039 | 2 | 27,200 | 29.0 | 170 | Do. |
| | | 26,400 | 30.0 | 156 | Do. |
| | | 23,000 | 29.0 | 149 | Fine granular dark gray. |
| 4040 | 2 | 22,400 | 33.0 | 163 | Do. |
| | | 27,400 | 32.0 | 170 | Fine granular gray. |

# GUN AND TOOL STEEL FOR ORDNANCE WORK.

## *Gun and tool steel from Watertown Arsenal smith shop.*

[Inch section in which fracture occurred is marked thus: *.]

| Marks. | Grade. | Elastic limit per square inch. | Tensile strength per square inch. | Elongation. | Contraction. | Elongation of inch sections. | | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Shore. | Brinell. | |
| | | *Lb.* | *Lb.* | *Per ct.* | *Per ct.* | *In.* | *In.* | | | |
| 160 F. F-1. | Gun steel. | 67,500 | 113,500 | 20.0 | 43.3 | 0.19*, | 0.21* | 33.0 | 217 | Dull silky. |
| 160 F. F-2. | ...do..... | 69,000 | 113,500 | 20.5 | 43.3 | .22*, | .19* | 30.5 | 228 | Do. |
| 345 F-2.... | Tool steel A. | 65,000 | 127,000 | 18.0 | 49.1 | .07, | .29* | 38.0 | ..... | Silky, 80 per cent; fine granular, 20 per cent. |
| 418 F-2.... | ...do..... | 87,500 | 136,500 | 17.5 | 46.2 | .08, | .27* | 38.0 | ..... | Fine granular; silky center. |
| 775 F..... | ...do..... | 80,500 | 126,000 | 15.0 | 46.2 | .26*, | .04 | 41.0 | ..... | Fine silky. |
| 817 F..... | ...do..... | 88,500 | 122,500 | 14.0 | 20.5 | .17*, | .11 | 42.0 | ..... | Fine granular, 70 per cent; amorphous spot, 30 per cent. |
| 818 F..... | Tool steel B. | 109,000 | 133,500 | 17.0 | 54.6 | .29*, | .05 | 38.0 | ..... | Fine silky; serrated. |
| 977 F..... | Tool steel A. | 112,000 | 169,000 | 12.0 | 27.4 | .18*, | .06 | ..... | ..... | Fine granular; silky spot in center. |
| | | 83,000 | 116,500 | 20.5 | 46.2 | .29*, | .12 | ..... | ..... | Fine granular. |
| | | 120,500 | 138,500 | 19.0 | 54.6 | .06, | .32* | 40.0 | ..... | Fine silky; serrated. |
| 1039 F..... | ...do..... | 58,000 | 112,000 | 19.0 | 30.7 | .14, | .24* | ..... | ..... | Fine granular, 85 per cent; silky, 15 per cent. |
| 1743 T..... | Gun steel. | 37,500 | 80,500 | 27.5 | 40.3 | .25*, | .30* | 22.5 | 143 | Silky. |
| 1743 FC..... | ...do..... | 46,000 | 92,500 | 26.5 | 43.3 | .29*, | .24 | 24.0 | 179 | Do. |
| 1741 FT..... | ...do..... | 63,000 | 101,000 | 24.0 | 54.6 | .36*, | .12 | 28.5 | 187 | Do. |
| 1741 FC..... | ...do..... | 68,000 | 101,000 | 23.0 | 62.0 | .30*, | .16 | 24.0 | 192 | Fine silky. |
| 1741 F-2C... | ...do..... | 70,000 | 107,000 | 20.0 | 58.0 | .30*, | .10 | 23.5 | 207 | Fine silky; cup shaped. |
| 1744 FC..... | ...do..... | 72,500 | 112,500 | 20.5 | 49.1 | .27*, | .14 | 30.0 | 217 | Silky. |
| 1744 F-2C... | ...do..... | 70,500 | 109,000 | 29.0 | 57.2 | .34*, | .24 | 28.5 | 207 | Fine silky; cup shaped. |
| 1744 FT..... | ...do..... | 72,000 | 116,000 | 19.5 | 43.3 | .22*, | .17 | 29.5 | 223 | Silky. |
| 1745 FC..... | ...do..... | 70,500 | 104,000 | 25.0 | 59.8 | .32*, | .18 | 29.0 | 192 | Silky, serrated. |
| 1745 F-2C... | ...do..... | 69,500 | 106,500 | 22.5 | 51.9 | .17, | .28* | 28.0 | 207 | Fine silky. |
| 1745 FT..... | ...do..... | 55,500 | 101,000 | 21.0 | 49.1 | .13, | .29* | 28.0 | 187 | Dull silky. |
| 1746 FT..... | ...do..... | 69,000 | 112,500 | 20.5 | 43.3 | .20*, | .21* | 32.0 | 223 | Silky. |
| | | 61,500 | 100,000 | 24.5 | 57.2 | .13, | .36* | 28.5 | 187 | Do. |
| 1747 FT..... | ...do..... | 78,500 | 125,000 | 15.5 | 30.7 | .12, | .19* | 31.0 | 241 | Fine granular; silky center. |
| 1748 FT..... | ...do..... | 67,500 | 110,000 | 20.5 | 46.2 | .29*, | .12 | 31.0 | 217 | Dull silky, trace granulation. |
| 1749 FC-1... | ...do..... | 74,500 | 122,500 | 16.0 | 30.7 | .20*, | .12 | 33.0 | 228 | Do. |
| 1749 FC-2... | ...do..... | 74,000 | 118,000 | 20.0 | 46.2 | .14, | .26* | 32.0 | 235 | Dull silky. |
| 1742 FC-1... | ...do..... | 49,000 | 103,000 | 14.0 | 34.0 | .21*, | .07 | 23.0 | 179 | Dull silky, 70 per cent; granular, 30 per cent. |
| 1742 FC-2... | ...do..... | 81,000 | 128,000 | 16.0 | 43.0 | .09, | .23* | 32.0 | 248 | Silky. |
| 1743 FC-1... | ...do..... | 83,000 | 129,000 | 15.0 | 34.0 | .18*, | .12 | 31.0 | 248 | Silky, 50 per cent; granular, 50 per cent. |
| 1743 FC-2... | ...do..... | 84,000 | 129,000 | 14.5 | 34.0 | .14*, | .15* | 31.0 | 255 | Fine granular; silky center. |
| 1750 FT..... | ...do..... | 67,000 | 110,500 | 21.0 | 43.3 | .21*, | .21* | 30.5 | 217 | Silky trace of granulation. |
| | ...do..... | 66,000 | 110,000 | 21.0 | 43.3 | .27*, | .15 | 31.0 | 217 | Silky. |
| 1751 FT..... | ...do..... | 65,500 | 110,000 | 21.5 | 49.1 | .31*, | .12 | 28.0 | 217 | Dull silky. |
| | ...do..... | 74,500 | 123,500 | 15.5 | 37.2 | .09, | .22* | 33.0 | 248 | Dull silky, 50 per cent; fine granular, 50 per cent. |

# PROOF TEST OF PISTON RODS AND CHAIN FOR ORDNANCE WORK.

## TEST 14704.

*PROOF STRESS APPLIED TO FOUR 15-PDR. PISTON RODS.*

Proof stress of 98,400-lb. tension applied to each rod.

| Marks on rods. | 1186 | | 1197 | | 1199 | | 1196 | |
|---|---|---|---|---|---|---|---|---|
| Applied loads. | In 10-in. gauge length. | | In 10-in. gauge length. | | In 10-in. gauge length. | | In 10-in. gauge length. | |
| | Elongation. | Set. | Elongation. | Set. | Elongation. | Set. | Elongation. | Set. |
| *Pounds.* | | | | | | | | |
| 500 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 98,400 | .0075 | ..... | .0075 | ..... | .0075 | ..... | .0075 | ..... |
| 500 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

No permanent set. Comply with specifications.

## TEST NO. 14754.

*PROOF STRESS APPLIED TO TWO 12-IN. MORTAR CARRIAGE PISTON RODS FOR WATERTOWN ARSENAL, MASS.*

Rods marked 12-in. mortar carr., model 1908, pilot, R. & L.
Proof stress called for 392,500 lb.
Proof stress applied, 396,000 lb., allowance being made for packing friction.
Readings taken on tension gauge of testing machine.
Elongations taken on 30-in. gauge length.

| Load. | Elongations. | |
|---|---|---|
| | Rod R. | Rod L. |
| *Lb.* | *In.* | *In.* |
| 0. | 0. | 0. |
| 396,000 | .0235 | .0235 |
| 0. | .0050 (micrometer disturbed). | 0.0008 |
| | Second time. | |
| 0. | 0. | 0. |
| 396,000 | .0232 | .0227 |
| 0. | 0. | 0. |

## TEST 14940.

*PROOF STRESS APPLIED TO TWO 14-IN. GUN TURRET PISTON RODS FOR WATERTOWN ARSENAL, MASS.*

Piston rods for 14-in. gun turret mounts, model 1909.

Load of 800,000-lb. tension applied to rods with the following results.

Elongations measured on gauge length of 30 in.

| Load. | Elongation in 30-in. length. | |
|---|---|---|
| | Rod 761. | Rod 766. |
| *Lb.* | *In.* | *In.* |
| 5,000 | 0. | 0. |
| 800,000 | .0197 | .0197 |
| 5,000 | .0006 | −.0001 |

Requirements.

Service 525,000 lb.

## TEST 14835.

*PROOF STRESS APPLIED TO SIX SPRING COMPRESSOR SCREWS FOR 12-IN. MORTAR CARRIAGE, MODEL 1908, FOR WATERTOWN ARSENAL, MASS.*

Marks on rods tested: 2104, 2105, 2141, 2142, 2143, and 2144.

Load of 60,000-lb. tension applied to each rod.

No sign of failure.

Required: Load of 60,000 lb.

## TEST 14776.

*TENSILE TESTS OF TWO PIECES OF $\frac{3}{8}$-IN. CHAIN FOR WATERTOWN ARSENAL.*

| | Number of links. | Diameter of wire. | Outside width of link. | Outside length of link. | Tensile strength. |
|---|---|---|---|---|---|
| | | *In.* | *In.* | *In.* | *Lb.* |
| First sample | 39 | 0.37 | 1.18 | 1.73 | 6,630 |
| Second sample | 39 | .37 | 1.21 | 1.73 | 6,324 |

First sample parted, fifteenth link at welded end.

Second sample parted, seventh link at welded end.

Requirements: Proof test, 3,640 lb. Average breaking strength, 7,280 lb. Safe load (ordinary), 2,427 lb.

## TEST 14821.

*PROOF STRESS APPLIED TO TWO PIECES OF ⅜-IN. CRANE CHAIN FOR WATERTOWN ARSENAL, MASS.*

Chain received on P. O. 1515.

DIMENSIONS.

| Marks. | Number of links. | Diameter of wire. | Outside width of links. | Length over all before test. | Length over all after test. | Elongations. |
|---|---|---|---|---|---|---|
| | | *In.* | *In.* | *In.* | *In.* | *In.* |
| Tag marked "Rejected" | 39 | 0.37 | 1.18–1.22 | 38.49 | 39.19 | 0.70 |
| | 39 | .37 | 1.16–1.24 | 38.25 | 38.92 | .67 |

Proof stress of 3,640-lb. tension was applied to each chain without damage to chains.

REQUIREMENTS.

⅜-in. wire, 1 1/2-in. pitch, 1¼ in. outside width of link. Proof test of 3,640 lb., average breaking strength 7,280 lb., ordinary safe load of 2,427 lb.

## TEST 14959.

*PROOF STRESS APPLIED TO TWO (2) PIECES OF ⅜-IN. STEEL CHAIN FOR WATERTOWN ARSENAL, MASS.*

| | Requirements. | Sample 1. | Sample 2. |
|---|---|---|---|
| Number of links | 39 | 40 | 40. |
| Diameter of wire | ⅜ in. | 0.40 in. | 0.40 in. |
| Length of link over all | 1 13/16 in. | Minimum, 1.74 in. | Minimum, 1.75 in. |
| | | Maximum, 1.85 in. | Maximum, 1.87 in. |
| Inside length of link | 11/16 in. | Minimum, 0.93 in. | Minimum, 0.92 in. |
| | | Maximum, 1.00 in. | Maximum, 1.03 in. |
| Inside width of link | ½ in. | Minimum, 0.53 in. | Minimum, 0.54 in. |
| | | Maximum, 0.57 in. | Maximum, 0.57 in. |
| Outside width of link | 1¼ in. | Minimum, 1.35 in. | Minimum, 1.33 in. |
| | | Maximum, 1.41 in. | Maximum, 1.39 in. |
| Proof stress | 3,640 lb. | 3,713 lb. | 3,713 lb. |

Requirements: No deviations from the above dimensions can be allowed.

A proof stress of 3,713 lb. tension was applied to each chain.

# MISCELLANEOUS TESTS FOR ORDNANCE WORK.

## TEST 14690.

*TENSILE TEST OF SEAMLESS BRASS TUBE FOR WATERTOWN ARSENAL, MASS. P. O. 9095.*

Direction of drawing, perpendicular (right angles) to axis of specimen.

| Marks. | Width. | Thickness. | Sectional area. | Tensile strength. | | Elongation in 8 inches. | |
|---|---|---|---|---|---|---|---|
| | | | | Load. | Stress per square inch. | | |
| None. | *In.* 1.50 | *In.* .285 | *Sq. in.* .428 | *Lb.* 16,300 | *Lb.* 38,100 | *In.* 1.98 | *Per cent.* 24.7 |

| After fracture. | | | Contraction of area. | Remarks. |
|---|---|---|---|---|
| Width. | Thickness. | Sectional area. | | |
| *In.* 1.26 | *In.* .21 | *Sq. in.* .264 | *Per cent.* 38.3 | Fracture 4.6 in. inside gauge mark. |

## TEST NO. 14795.

*TUBE AND FRICTION TESTS FROM A PIECE OF 7-PLY ½-IN. PNEUMATIC HOSE FOR WATERTOWN ARSENAL, WATERTOWN, MASS.*

The 12-in. sample represents 400 ft. of ½-in. 7-ply hose, received on P. O. 1068.

### TUBE TEST.

Length of sample over all, 6 in.

Width of sample, 1 in.

A gauge length of 2 in. was laid off on sample. The sample was then stretched until the gauge marks were 6 in. apart and held in this position for 10 minutes.

Distance between gauge marks after sample had rested for 10 minutes, 2.25 in.

Permanent set, 0.25 in. Complies with the specifications.

### REQUIRED FOR TUBE TEST.

Distance between gauge marks after sample had rested 10 minutes not to be greater than 2¼ in.

Permanent set not to be more than 0.25 in.

FRICTION TEST.

Length of samples, 1 in.
Two samples tested.
First sample unwound 2.80 in. in 10 minutes.
Second sample unwound 2.90 in. in 10 minutes.

REQUIRED FOR FRICTION TEST.

Fabric must not unwind at a greater rate of speed than 6 in. in 10 minutes.

## TEST 14809.

*HARDNESS TEST ON A BEVEL GEAR BLANK FOR 14-INCH-GUN TURRET FOR WATERTOWN ARSENAL, MASS.*

Gear blank received from machine shop February 16, 1912.
Marks on blank, 1019, $37_1$B.
Hardness taken on both sides of the gear with Brinell's hardness instrument, and also with the Shore scleroscope.
Results of hardness as follows: Brinell's instrument, 302 to 340; Shore scleroscope, 54 to 56.
Forged steel specimens have a hardness by the Brinell test of about 200, and by the scleroscope of about 30.

## TEST 14822.

*TENSILE TEST OF A STRAIN INSULATOR FOR WATERTOWN ARSENAL, MASS.*

The insulator consists of two malleable-iron castings with one-half in. eyes at one end of each. At the other end the two castings locked together and were covered with a composition ball two and one quarter in. in diameter, the composition ball forming the insulation.
Tensile strength, 6,426 lb.
Fractured the composition ball into 9 principal fragments.
Composition covering removed and test continued.
At 4,896 lb. fractured the malleable-iron casting near the base which was covered by the composition ball.

## TEST 14895.

*COMPRESSIVE TESTS OF STEEL BALLS FOR WATERTOWN ARSENAL, MASS.*

Balls tested between hardened steel faces. Number of balls tested 3.

| Nominal size. | Diameter of balls. | Required load. | Ultimate strength. |
|---|---|---|---|
| *In.* | *In.* | *Lb.* | *Lb.* |
| ½ | 0.1242 to 0.1248 | 1,300 | 1,677 |
| ⅛ | .1247 to .1251 | 1,300 | 3,698 |
| ½ | .2503 | 5,200 | 5,529 |

## TEST 14955.

*TENSILE TESTS OF STEEL SPECIMENS TAKEN FROM BROKEN RAIL FROM TRACK IN YARD OF WATERTOWN ARSENAL.*

For location of specimens see photograph. Nos. 1 and 2 refer to specimens taken from head of rail, No. 3 specimens taken from junction of web and base of rail.

| Marks. | Diameter. | Sectional area. | Elastic limit. | | Tensile strength. | | Elongation in 2 inches. | |
|---|---|---|---|---|---|---|---|---|
| | | | Load. | Stress per square inch. | Load. | Stress per square inch. | | |
| | *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Lb.* | *Lb.* | *In.* | *P. ct.* |
| B 1 | 0.505 | 0.20 | 14,100 | 70,500 | 25,900 | 129,500 | 0.17 | 8.5 |
| B 2 | .505 | .20 | 14,800 | 74,000 | 25,900 | 129,500 | .24 | 12.0 |
| B 3 | .505 | .20 | 14,100 | 70,500 | 26,000 | 130,000 | .30 | 15.0 |
| D 1 | .505 | .20 | 14,400 | 72,000 | 25,800 | 129,000 | .24 | 12.0 |
| D 2 | .505 | .20 | 14,000 | 70,000 | 25,700 | 128,500 | .25 | 12.5 |
| D 3 | .505 | .20 | 14,100 | 70,500 | 25,900 | 129,500 | .29 | 14.5 |
| F 2 | .505 | .20 | 15,100 | 75,500 | 26,100 | 130,500 | .20 | 10.0 |
| F 3 | .505 | .20 | 14,100 | 70,500 | 25,900 | 129,500 | .30 | 15.0 |

| Marks. | Elongation in inch sections. | Diameter at fracture. | Contraction of area. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|
| | | | | Brinell. | Shore scleroscope. | |
| | *In.* *In.* | *In.* | *P. ct.* | | | |
| B 1 | 0.09*, 0.08* | 0.48 | 9.5 | 235 | 33.5 | Fine granular. |
| B 2 | .10, .14* | .46 | 16.9 | 255 | 33.0 | Do. |
| B 3 | .17*, .13 | .44 | 24.0 | 248 | 32.5 | Do. |
| D 1 | .14*, .10 | .47 | 13.3 | 248 | 33.5 | Do. |
| D 2 | .14*, .11 | .46 | 16.9 | 241 | 32.0 | Do. |
| D 3 | .17*, .12 | .44 | 24.0 | 241 | 33.0 | Do. |
| F 2 | .08, .12* | .47 | 13.3 | 248 | 33.0 | Do. |
| F 3 | .13, .17* | .44 | 24.0 | 241 | 32.0 | Do. |

## TEST 14713.

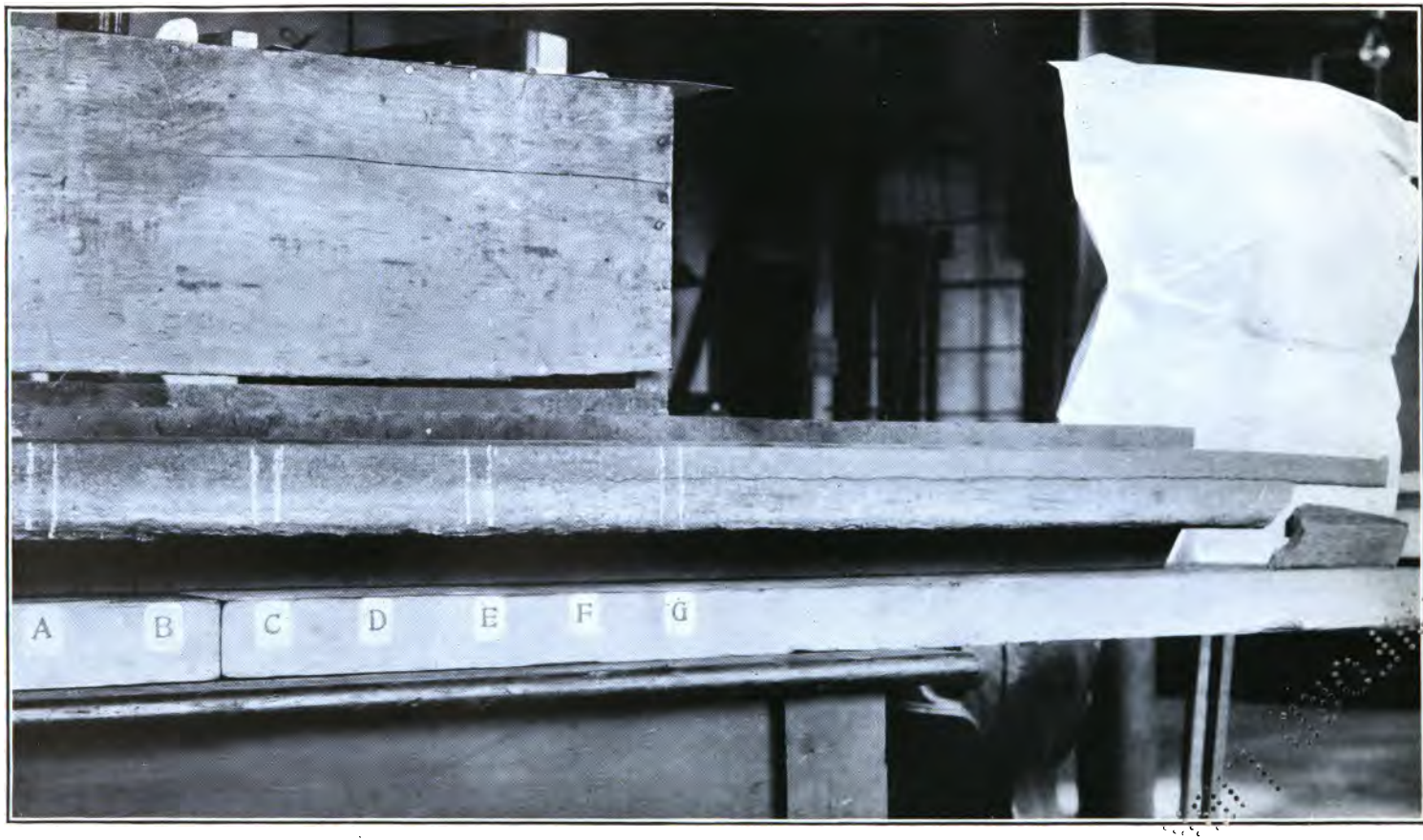
*REPORT UPON THE STRENGTH OF TEETH IN PAWL AND RACK OF 14-IN. D. C., MODEL OF 1907.*

A section of the rack was cut off about 14 in. long, and the width reduced to about that of the rack teeth. This piece of rack and pawl was then held in the gripping jaws of the testing machine.

The teeth were engaged in the same relative position that they occupy in the carriage. The center line of the testing machine passed through the center of the pinhole in the pawl, and the center of the bearing surfaces of the engaged teeth.

The diagonal line in Photograph 1200–B was used as a guide in setting the pieces.

The load was applied gradually without noticeable effect until the teeth began to bend. The inclined surfaces which resulted caused the pawl and rack to separate about ¼ in., due chiefly to springing of the piston rod of the testing machine.




LOCATION OF TEST SPECIMENS.

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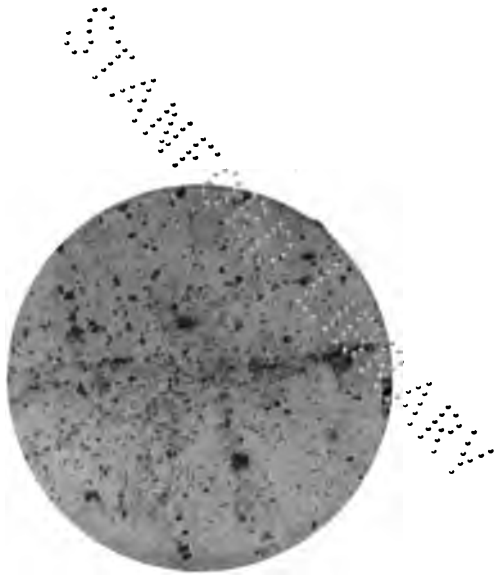
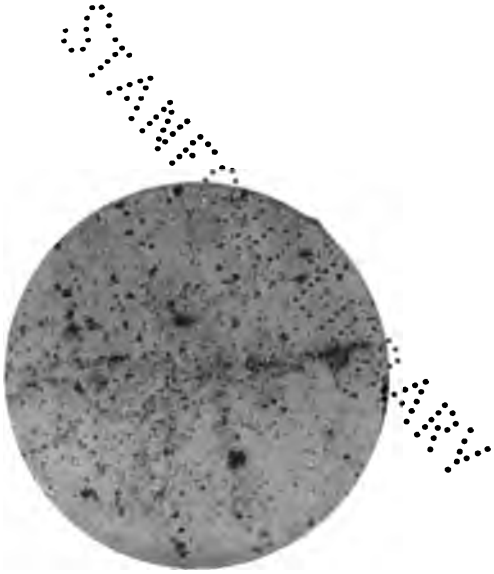
NO.1. SECTION A. UNETCHED. X50.



NO.2. SECTION E. UNETCHED. X50.

NO.3. SECTION A. ETCHED. X50.

NO.1. SECTION A. UNETCHED. X50.



NO.2. SECTION E. UNETCHED. X50.

NO.3. SECTION A. ETCHED. X50.

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NO. 4. SECTION A. ETCHED. X 50.

NO. 5. SECTION E, X 50.

HELIOTYPE CO., BOSTON

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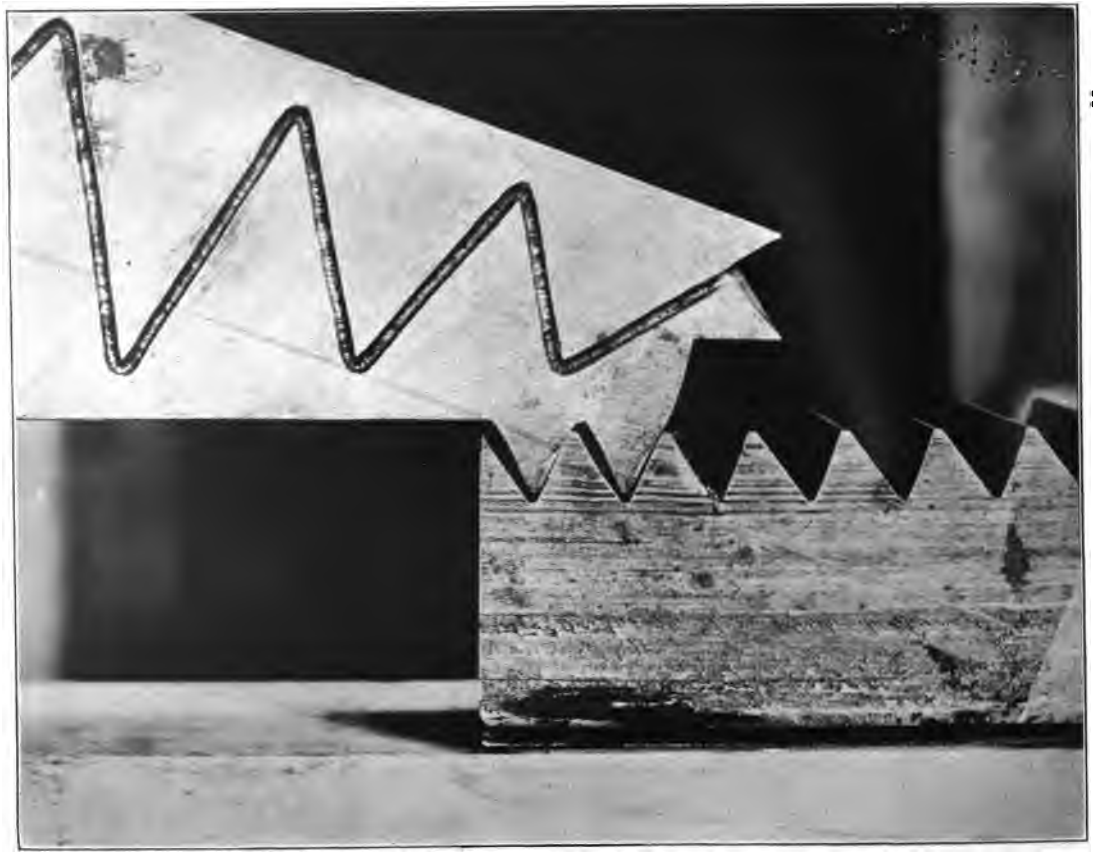
PHOTOGRAPH 1201B.



PHOTOGRAPH 1200B.

A load of 324,000 lb. was reached, then the test discontinued. The teeth of the rack were displaced 0.23 in. at the points as shown by photograph 1201–B.

The deformation of the pawl teeth could not well be measured, but the photographs show it quite clearly, especially by the tool marks in 1200–B.

It is believed that the ultimate strength of these teeth was reached. To cause greater deformation in the carriage it would be necessary to lock the pawl into its engaged position.

## TEST 14735.

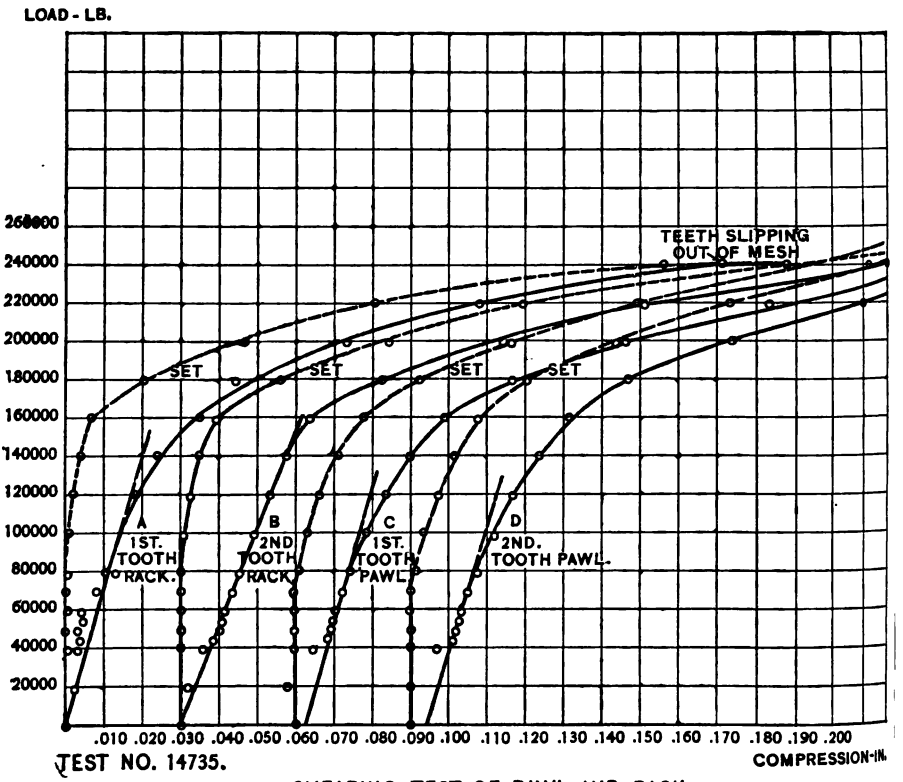
*SHEARING TEST OF RACK AND PAWL FOR 14-IN. D. C., MODEL 1907, FOR WATERTOWN ARSENAL, WATERTOWN, MASS.*

Gauge lengths approximately 2.10 in.

| Load. | A. | | B. | | C. | | D. | |
|---|---|---|---|---|---|---|---|---|
| | Extensometer. | Compression. | Extensometer. | Compression. | Extensometer. | Compression. | Extensometer. | Compression. |
| *Lb.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* | *In.* |
| 20,000 | 0.1189 | 0.0029 | 0.0821 | 0.0021 | 0.0415 | −0.0015 | 0.0218 | 0.0008 |
| 40,000 | .1197 | .0037 | .0867 | .0067 | .0480 | .0050 | .0280 | .0070 |
| | .1198 | .0038 | .0865 | .0065 | .0480 | .0050 | .0280 | .0070 |
| 2,000 | .1165 | .0005 | .0800 | 0 | .0430 | 0 | .0210 | 0 |
| 45,000 | .1200 | .0040 | .0892 | .0092 | .0520 | .0090 | .0325 | .0115 |
| 50,000 | .1200 | .0040 | .0910 | .0110 | .0527 | .0097 | .0332 | .0122 |
| 2,000 | .1160 | 0 | .0800 | 0 | .0430 | 0 | .0210 | 0 |
| 55,000 | .1211 | .0051 | .0915 | .0115 | .0538 | .0108 | .0341 | .0131 |
| 60,000 | .1205 | .0045 | .0920 | .0120 | .0541 | .0111 | .0349 | .0139 |
| 2,000 | .1163 | .0003 | .0800 | 0 | .0430 | 0 | .0210 | 0 |
| 70,000 | .1241 | .0081 | .0940 | .0140 | .0559 | .0129 | .0362 | .0152 |
| 2,000 | .1160 | 0 | .0800 | 0 | .0430 | 0 | .0210 | 0 |
| 80,000 | .1268 | .0108 | .0960 | .0160 | .0580 | .0150 | .0387 | .0177 |
| | .1298 | .0138 | | | | | | |
| 2,000 | .1168 | .0008 | .0802 | .0002 | .0442 | .0012 | .0222 | .0012 |
| 100,000 | .1308 | .0148 | .0997 | .0197 | .0620 | .0190 | .0432 | .0222 |
| 2,000 | .1168 | .0008 | .0812 | .0012 | .0446 | .0036 | .0250 | .0040 |
| 120,000 | .1349 | .0189 | .1039 | .0239 | .0670 | .0240 | .0485 | .0275 |
| 2,000 | .1182 | .0022 | .0832 | .0032 | .0500 | .0070 | .0287 | .0077 |
| 140,000 | .1402 | .0242 | .1085 | .0285 | .0732 | .0302 | .0550 | .0340 |
| 2,000 | .1200 | .0040 | .0860 | .0060 | .0542 | .0112 | .0330 | [1].0120 |
| | .1200 | .0040 | .0852 | .0052 | .0530 | .0100 | .0327 | .0117 |
| 160,000 | .1465 | .0305 | .1143 | .0343 | .0825 | .0395 | .0633 | .0423 |
| 2,000 | .1230 | .0070 | .0900 | .0100 | .0610 | .0180 | .0393 | .0183 |
| 180,000 | .1610 | .0450 | .1330 | .0530 | .1000 | .0570 | .0786 | .0576 |
| 2,000 | .1370 | .0210 | .1065 | .0265 | .0757 | .0327 | .0520 | .0310 |
| 200,000 | .1900 | .0740 | .1645 | .0845 | .1298 | .0868 | .1060 | .0850 |
| 2,000 | .1630 | .0470 | .1350 | .0550 | .1000 | .0570 | .0750 | .0540 |
| 220,000 | .2245 | .1085 | .2020 | .1220 | .1667 | .1237 | .1410 | .1200 |
| 2,000 | .1975 | .0815 | .1700 | .0900 | .1330 | .0900 | .1050 | .0840 |
| 240,000 | .2880 | .1720 | .2710 | .1910 | .2110 | .1680 | .1700 | [2].1490 |
| 2,000 | .2730 | .1570 | .2380 | .1580 | .1770 | .1340 | .1440 | .1230 |

[1] Specimens rested one hour under initial load.
[2] Teeth slipped out of mesh showing an opening of 0.15 in.

NOTE.—A is the distance from a fixed point on the rack to a point on the 1st tooth of the rack measured parallel to the direction of the load. Similarly B is the distance to the point of the second tooth and C and D are similar distances measured on the 1st and 2d teeth of the pawl.




SHEARING TEST OF PAWL AND RACK
14-IN. D. C. CARRIAGE, MODEL OF 1907.

# HOLLOW-DECK STANCHIONS.

## TEST 14715.

*TENSILE TESTS ON 5-IN. HOLLOW DECK STANCHIONS, ¼-IN. WALLS, FOR NEW YORK NAVY YARD, NEW YORK.*

Stanchions 6 ft. 6 in. in length, fitted with drop forged heads and heels.

| No. | Manner of fastening head and foot. | Tensile strength. | Manner of failure. |
|---|---|---|---|
| | | *Lb.* | |
| 1 | Special fitting | 43,000 | Fractured the pipe or tubing in thread, at edge of head or foot, 1¾ in. from end. |
| 2 | do | 56,900 | Do. |
| 3 | Screwed on taper thread | 118,000 | Sheared the thread. At 117,000 lb. threads begin to come out. |
| 4 | do | 107,900 | Bent the head or foot and sheared the thread. |
| 5 | Shrunk on and riveted | 162,200 | Sheared two rivets and split the pipe or tubing longitudinally at the two rivet holes. |
| 6 | Screwed on parallel thread | 163,100 | Fractured the pipe or tubing 5⅜ in. from end. |
| 7 | Shrunk on | 107,000 | Drew head ⅛ in. and foot ⅜ in. from pipe or tubing. |
| 8 | do | 120,400 | Drew head or foot 4¼ in. from pipe or tubing. Carried away portion of tubing. |
| 9 | Screwed on parallel thread | 197,900 | Fractured the pipe or tubing 5¾ in. from end. Diameter of tubing after fracture, outside 5 in., inside 4.25 in., ⅜ in. thick. |
| 10 | Shrunk on and riveted | 175,200 | Sheared one rivet and split the pipe or tubing longitudinally at the two rivet holes. |
| 11 | Welded | 221,600 | Fractured the pipe or tubing 13 in. from end. Diameter of tubing at point of fracture, outside 4.75 in., inside 4.15 inches. |
| 12 | do | 209,200 | Fractured the pipe or tubing 13 in. from end. Elongation of tubing measured on two gauged lengths including 1/16-in. opening at fracture as follows: |
| | | | After fracture.....84.20 in. 78.30 in. |
| | | | Before fracture.....80.35 in. 74.45 in. |
| | | | Elongation..... 3.85 in. 3.85 in. |

Sharp snapping sounds occurred at the following loads: 66,900 lb., 78,000 lb., and 81,100 lb.

# STEEL SPECIMENS FOR COMPARISON OF TESTING MACHINES.

## TEST 14717.

*TENSILE TESTS OF THREE STEEL SPECIMENS FOR SPRINGFIELD ARMORY, SPRINGFIELD, MASS.*

For standardizing testing machine at armory with large machine at Watertown Arsenal.

[Inch section in which fracture occurred is marked thus *.]

| Diameter. | Sectional area. | Elastic limit. | | Tensile strength. | |
|---|---|---|---|---|---|
| | | Load. | Stress per square inch. | Load. | Stress per square inch. |
| *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Lb.* | *Lb.* |
| 0.505 | 0.20 | 12,600 | 63,000 | 19,900 | 99,500 |
| .505 | .20 | 14,400 | 72,000 | 21,100 | 105,500 |
| .505 | .20 | 13,100 | 65,500 | 20,200 | 101,000 |

| Elongation in 2 inches. | | Elongation of inch sections. | | Diameter at fracture. | Contraction of area. | Appearance of fracture. |
|---|---|---|---|---|---|---|
| *In.* | *P. ct.* | *In.* | *In.* | *In.* | *P. ct.* | |
| 0.55 | 27.5 | 0.17, | 0.38* | 0.32 | 59.8 | Fine silky; cup shaped. |
| .51 | 25.5 | .12, | .39* | .32 | 59.8 | Fine silky. |
| .56 | 28.0 | .19, | .37* | .34 | 54.6 | Do. |

## TEST 14733.

### *TENSILE TESTS OF FIVE STEEL SPECIMENS FOR CALIBRATION OF THE EMERY TESTING MACHINE, BETHLEHEM STEEL CO.*

Steel specimens taken from bar of forged steel (either No. 1 or No. 2), furnished by the Bethlehem Steel Co. Tested on 800,000-lb. machine.

[Inch section in which fracture occurred is marked thus *.]

| Marks. | Diameter. | Sectional area. | Elastic limit. | | Tensile strength. | |
|---|---|---|---|---|---|---|
| | | | Load. | Stress per square inch. | Load. | Stress per square inch. |
| | *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Lb.* | *Lb.* |
| D 2676- 2 | 0.5048 | 0.20014 | 7,400 | 36,974 | 13,822 | 69,062 |
| D 2676- 4 | .5048 | .20014 | 7,400 | 36,974 | 13,750 | 68,703 |
| D 2676- 6 | .5050 | .20030 | 7,400 | 36,944 | 13,740 | 68,597 |
| D 2676- 8 | .5050 | .20030 | 7,400 | 36,944 | 13,755 | 68,672 |
| D 2676-10 | .5051 | .20038 | 7,500 | 37,430 | 13,810 | 68,920 |

| Marks. | Elongation in 2 inches. | | Elongations inch sections. | | Diameter at fracture. | Contraction of area. | Appearance of fracture. |
|---|---|---|---|---|---|---|---|
| | *In.* | *P. ct.* | *In.* | *In.* | *In.* | *P. ct.* | |
| D 2676- 2 | 0.75 | 37.5 | 0.29, | 0.46* | 0.31 | 62.29 | Fine silky. |
| D 2676- 4 | .74 | 37.0 | .44,* | .30 | .30 | 64.68 | Fine silky; cup shaped. |
| D 2676- 6 | .76 | 38.0 | .34, | .42* | .31 | 62.32 | Fine silky. |
| D 2676- 8 | .74 | 37.0 | .49,* | .25 | .30 | 64.71 | Do. |
| D 2676-10 | .76 | 38.0 | .43,* | .33 | .30 | 64.72 | Do. |

## TEST 14823.

*TENSILE TEST OF STEEL SPECIMENS FOR CALIBRATING EMERY-TESTING MACHINE AT SOUTH BETHLEHEM, PA., FOR W. D. GREETHAM, UNITED STATES NAVY, INSPECTOR OF ORDNANCE.*

| Marks. | Diameter. | Sectional area. | Elastic limit. | | Tensile strength. | |
|---|---|---|---|---|---|---|
| | | | Load. | Stress per square inch. | Load. | Stress per square inch. |
| | *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Lb.* | *Lb.* |
| Z 2768 | 0.5052 | 0.20043 | 8,400 | 41,910 | 13,500 | 67,358 |
| Z 2784 | .5052 | .20043 | 11,700 | 58,379 | 21,400 | 106,760 |

| Marks. | Elongation in 2 inches. | | Elongation of inch sections. | | Diameter at fracture. | Contraction of area. | Appearance of fracture. |
|---|---|---|---|---|---|---|---|
| | *In.* | *P. ct.* | *In.* | *In.* | *In.* | *P. ct.* | |
| Z 2768 | 0.74 | 37.0 | 0.34, | 0.40 | 0.32 | 59.8 | Fine silky. |
| Z 2784 | .44 | 22.0 | .21 | .23 | .39 | 40.3 | Silky. |

## TEST 14823.

*TENSILE TEST OF STEEL SPECIMENS FOR CALIBRATION OF EMERY-TESTING MACHINE AT SOUTH BETHLEHEM, PA., FOR W. D. GREETHAM, UNITED STATES NAVY, INSPECTOR OF ORDNANCE.*

Marks, Z 2764.
Diameter, 0.5047 in.
Sectional area, 0.20012 sq. in.
Gauged length, 2 in.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Load. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 1,020 | 5,094 | 0. | 0. | |
| 2,040 | 10,194 | .0003 | .00015 | |
| 5,100 | 25,485 | .0014 | .00070 | |
| 6,120 | 30,581 | .0018 | .00090 | |
| 6,324 | 31,601 | .0020 | .00100 | |
| 6,528 | 32,620 | .0021 | .00105 | |
| 6,732 | 33,640 | .0022 | .00108 | |
| 6,936 | 34,660 | .0022 | .00110 | |
| 7,140 | 35,679 | .0023 | .00115 | |
| 7,344 | 36,698 | .0025 | .00123 | |
| 7,548 | 37,720 | .0025 | .00125 | |
| 7,752 | 38,736 | .0026 | .00130 | |
| 7,956 | 39,755 | .0028 | .00138 | Elastic limit. |
| 8,160 | 40,778 | .0345 | .01725 | |
| 8,364 | 41,795 | .0362 | .01810 | |
| 8,568 | 42,812 | .0387 | .01935 | |
| 13,566 | 67,789 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.36, 0.35 in.
Elongation after fracture, 0.71 in. = 35.5 per cent.
Diameter at fracture, 0.32 in.
Contraction of area, 59.8 per cent.
Position of fracture, at the middle.
Appearance of fracture, fine silky; cup shaped.

## TEST 14823.

Marks, Z 2780.
Diameter, 0.5050 in.
Sectional area, 0.20030 sq. in.
Gauged length, 2 in.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Total. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 1,020 | 5,092 | 0. | 0. | |
| 2,040 | 10,185 | .0004 | .00020 | |
| 6,120 | 30,555 | .0019 | .00095 | |
| 8,160 | 40,740 | .0026 | .00130 | |
| 9,180 | 45,834 | .0030 | .00150 | |
| 9,384 | 46,852 | .0031 | .00155 | |
| 9,588 | 47,870 | .0032 | .00160 | |
| 9,792 | 48,890 | .0033 | .00165 | |
| 9,996 | 49,910 | .0034 | .00170 | |
| 10,200 | 50,923 | .0035 | .00175 | |
| 10,403 | 51,940 | .0036 | .00180 | |
| 10,608 | 52,960 | .0037 | .00183 | |
| 10,812 | 53,980 | .0038 | .00188 | |
| 11,016 | 55,000 | .0039 | .00195 | |
| 11,220 | 56,019 | .0040 | .00200 | |
| 11,424 | 57,041 | .0041 | .00203 | |
| 11,628 | 58,059 | .0042 | .00210 | |
| 11,830 | 59,064 | .0044 | .00220 | Elastic limit. |
| 12,036 | 60,710 | .0167 | .00835 | |
| 12,240 | 61,110 | .0172 | .00860 | |
| 21,521 | 107,450 | ..... | ..... | Tensile strength. |

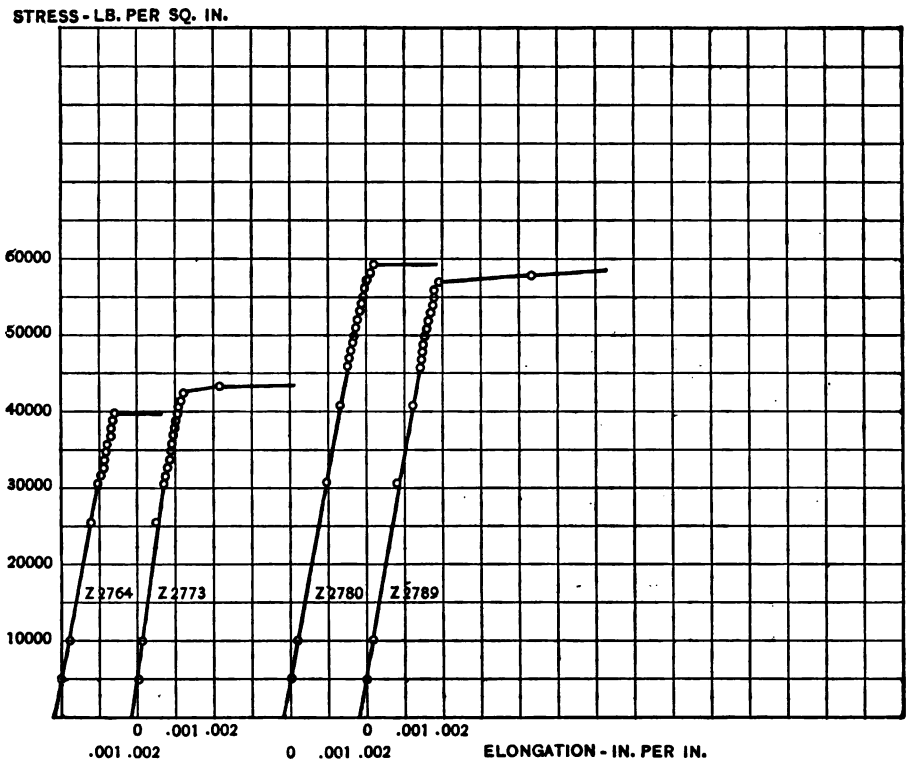
Elongation after fracture, 0.44 in. in 2 in. = 22 per cent.
Elongation of inch sections, 0.29,* 0.15 in.
Diameter at fracture, 0.39 in.
Contraction of area, 40.3 per cent.
Position of fracture, 1 in. from the neck.
Appearance of fracture, silky.

## TEST 14823.

Marks, Z 2789.
Diameter, 0.5053 in.
Sectional area, 0.20060 sq. in.
Gauged length, 2 in.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Load. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 1,020 | 5,085 | 0. | 0. | |
| 2,040 | 10,170 | .0003 | .00015 | |
| 6,120 | 30,510 | .0016 | .00080 | |
| 8,160 | 40,682 | .0024 | .00120 | |
| 9,180 | 45,768 | .0028 | .00140 | |
| 9,384 | 46,780 | .0029 | .00145 | |
| 9,588 | 47,800 | .0030 | .00148 | |
| 9,792 | 48,820 | .0030 | .00150 | |
| 9,996 | 49,836 | .0031 | .00155 | |
| 10,200 | 50,850 | .0032 | .00160 | |
| 10,403 | 51,870 | .0033 | .00163 | |
| 10,608 | 52,890 | .0034 | .00170 | |
| 10,812 | 53,900 | .0035 | .00175 | |
| 11,016 | 54,920 | .0036 | .00178 | |
| 11,220 | 55,935 | .0036 | .00180 | |
| 11,424 | 56,960 | .0038 | .00190 | Elastic limit. |
| 11,576 | 57,710 | .0087 | .00435 | |
| 11,830 | 58,950 | .0140 | .00700 | |
| 12,036 | 60,010 | .0149 | .00745 | |
| 12,240 | 61,020 | .0163 | .00815 | |
| 21,622 | 107,690 | ..... | ..... | Tensile strength. |

Elongation after fracture, 0.45 in. in 2 in. = 22.5 per cent.
Elongation of inch sections, 0.19, 0.26* in.
Diameter at fracture, 0.39 in.
Contraction of area, 40.3 per cent.
Position of fracture, 1.25 in. from the neck.
Appearance of fracture, silky.




TEST NO. 14823.

TENSILE TEST OF STEEL SPECIMEN
FOR INSPECTOR OF ORDNANCE U.S.N. AT SO. BETHLEHEM, PENN.

## TEST 14861.

### *TENSILE TEST OF STEEL SPECIMENS FOR CALIBRATION OF TESTING MACHINE AT THE PARK WORKS OF THE CRUCIBLE STEEL CO. OF AMERICA, PITTSBURGH, PA.*

[Inch section in which fracture occurred is marked *.]

| Marks. | Diameter. | Sectional area. | Elastic limit. | | Tensile strength. | | Elongation in 2 inches. | |
|---|---|---|---|---|---|---|---|---|
| | | | Load. | Stress per square inch. | Load. | Stress per square inch. | Inch. | Per cent. |
| | *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Lb.* | *Lb.* | | |
| 2 | 0.5046 | 0.19999 | 8,260 | 41,302 | 14,500 | 72,980 | 0.68 | 34.0 |
| 4 | .5043 | .19974 | 8,470 | 42,408 | 14,500 | 73,046 | .68 | 34.0 |
| 6 | .5045 | .19990 | 8,470 | 42,418 | 14,480 | 72,449 | .72 | 36.0 |
| 8 | .5039 | .19942 | 9,080 | 45,532 | 14,380 | 72,110 | .69 | 34.5 |
| 10 | .5048 | .20013 | 8,770 | 43,820 | 14,480 | 72,355 | .67 | 33.5 |
| 12 | .5049 | .20021 | 8,360 | 41,758 | 14,500 | 72,872 | .70 | 35.0 |

| Marks. | Elongation in inch sections. | Diameter at fracture. | Contraction of area. | Appearance of fracture. |
|---|---|---|---|---|
| | *In.* *In.* | *In.* | *P. ct.* | |
| 2 | 0.25, 0.43* | 0.33 | 57.2 | Fine silky. |
| 4 | .44,* .24 | .33 | 59.8 | Silky. |
| 6 | .29, .43* | .33 | 57.2 | Fine silky. |
| 8 | .37,* .32* | .34 | 54.6 | Silky. |
| 10 | .46,* .21 | .33 | 57.2 | Do. |
| 12 | .46,* .24 | .33 | 57.2 | Do. |

## TEST 14947.

### *TENSILE TEST OF SIX STEEL SPECIMENS FOR TITUSVILLE FORGE CO., TITUSVILLE, PA.*

These six specimens are in connection with the standardizing of the new Riehlé 150,000-lb. testing machine at the Titusville Forge Co., Titusville, Pa.

[Inch section in which fracture occurred is marked thus *.]

| Marks. | Diameter. | Sectional area. | Elastic limit. | | Tensile strength. | | Elongation in 2 inches. | |
|---|---|---|---|---|---|---|---|---|
| | | | Load. | Stress per square inch. | Load. | Stress per square inch. | Inch. | Per cent. |
| | *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Lb.* | *Lb.* | | |
| 2 | 0.5040 | 0.19951 | 13,770 | 69,024 | 16,116 | 80,775 | 0.39 | 19.5 |
| 4 | .5049 | .20023 | 13,872 | 69,280 | 16,116 | 80,480 | .39 | 19.5 |
| 6 | .5039 | .19942 | 13,770 | 69,045 | 16,014 | 80,310 | .39 | 19.5 |
| 8 | .5045 | .19990 | 13,566 | 67,862 | 16,116 | 80,625 | .40 | 20.0 |
| 10 | .5049 | .20023 | 13,668 | 68,262 | 16,014 | 79,980 | .40 | 20.0 |
| 12 | .5044 | .19980 | 13,770 | 68,920 | 16,014 | 80,160 | .40 | 20.0 |

| Marks. | Elongation in inch sections. | | Diameter at fracture. | Contraction of area. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|---|
| | | | | | Brinell method. | Shore scleroscope. | |
| | *In.* | *In.* | *In.* | *P. ct.* | | | |
| 2 | 0.30,* | 0.09 | .33 | 57.1 | 166 | 29.0 | Fine silky; cup shaped. |
| 4 | .30,* | .09 | .32 | 59.8 | 163 | 28.5 | Fine silky. |
| 6 | .30,* | .09 | .32 | 59.6 | 163 | 30.0 | Do. |
| 8 | .32,* | .08 | .32 | 59.7 | 163 | 28.0 | Do. |
| 10 | .09 | .31* | .32 | 59.8 | 163 | 29.0 | Do. |
| 12 | .27,* | .13 | .32 | 59.7 | 163 | 29.0 | Do. |

Elastic limit not well defined.

## TEST 14949.

*TENSILE TESTS OF THREE STEEL SPECIMENS FOR BUILDERS IRON FOUNDRY, PROVIDENCE, R. I.*

For use in calibrating testing machines at their works and at Brown University, in connection with Builders Iron Foundry contract for 12-in. M. C., Model 1896 M111.

| Marks. | Diameter. | Sectional area. | Elastic limit. | | Tensile strength. | |
|---|---|---|---|---|---|---|
| | | | Load. | Stress per square inch. | Load. | Stress per square inch. |
| | *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Lb.* | *Lb.* |
| 1 | 0.7973 | 0.49938 | 21,930 | 43,915 | 37,128 | 74,324 |
| 3 | .7982 | .50020 | 23,154 | 46,290 | 36,800 | 73,540 |
| 5 | .7981 | .50012 | 23,562 | 47,115 | 36,414 | 72,808 |

| Elongation in 8 inches. | | Diameter at fracture. | Contraction of area. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|
| Inches. | Per cent. | | | Brinell method. | Shore method. | |
| | | *In.* | *P. ct.* | | | |
| 2.06 | 25.75 | 0.57 | 48.9 | 118 | 29.0 | Fine silky. |
| 1.95 | 24.37 | .59 | 45.3 | 126 | 28.0 | Do. |
| 1.97 | 24.62 | .58 | 47.2 | 118 | 28.5 | Fine silky; cup shaped. |

# CORDAGE—MANILA ROPE—STEEL WIRE ROPE.

## TEST 14697.

*TENSILE TESTS OF SAMPLES OF THREE-STRAND MANILA ROPE FOR WATERTOWN ARSENAL.*

Samples prepared for testing with eye splices at the ends. Splices wet 7 hours before testing. Length between splices, 5 to 6 feet.

| From bale No. | Nominal circumference. | Actual— | | Sectional area. | Tensile strength. | |
|---|---|---|---|---|---|---|
| | | Circumference. | Diameter. | | Load. | Stress per square inch. |
| | *In.* | *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* |
| 1 | 8.00 | 8.90 | 2.90 | 6.61 | 48,400 | 7,320 |
| 2 | 8.00 | 9.10 | 2.87 | 6.47 | 44,500 | 6,880 |
| 3 | 8.00 | 9.00 | 2.95 | 6.83 | 43,700 | 6,400 |
| 4 | 8.00 | 8.95 | 2.90 | 6.61 | 45,100 | 6,820 |

| From bale No. | Length of sample. | Weight of sample. | Breaking length.[1] | Parted. |
|---|---|---|---|---|
| | *Ft. in.* | *Lb.* | *Ft.* | |
| 1 | 17 10 | 34 | 25,300 | 1 strand at the splice. |
| 2 | 18 4 | 34 | 24,000 | Do. |
| 3 | 18 1 | 34 | 23,200 | Do. |
| 4 | 17 11 | 33 | 24,300 | Do. |

[1] The "breaking length" is a term which is in use in Germany in reference to material of which it is difficult to obtain the cross-sectional area accurately, such as paper, leather, rope, etc. It is the length in feet which a specimen must have in order to break of its own weight when suspended by one end, and is computed by dividing the ultimate tensile strength in pounds by the weight of the specimen in pounds per foot of length.

The merit of this determination lies in its definiteness and, in the case of material purchased by weight, in the fact that "loading" the material carries its own penalty.

## TEST 14698.

*ADDITIONAL TESTS ON MANILA ROPE.*

| No. | Nominal— | | Actual— | | Sectional area. | Tensile strength. | |
|---|---|---|---|---|---|---|---|
| | Diameter. | Circumference. | Diameter. | Circumference. | | Load. | Stress per square inch. |
| | *In.* | *In.* | *In.* | *In.* | *Sq. in.* | *Lb.* | *Sq. in.* |
| 1 | ⅜ | ..... | 0.37 | 1.35 | 0.108 | 1,220 | 11,300 |
| 2 | ..... | 5.00 | 1.80 | 5.65 | 2.54 | 22,100 | 8,700 |
| 3 | ..... | 11.00 | 3.85 | 11.85 | 11.64 | 71,300 | 6,130 |

| No. | Length of sample. | Weight of sample. | Breaking length. | Parted. |
|---|---|---|---|---|
| | *Ft. in.* | *Lb.* | *Ft.* | |
| 1 | 17 9 | ¾ | 28,900 | 1 strand 17 in. from the splice. |
| 2 | 18 4 | 14 | 28,900 | 1 strand at the splice. |
| 3 | 18 4 | 65 | 20,100 | Do. |

## TEST 14699.

*TENSILE TEST OF ONE SAMPLE OF THREE-STRAND MANILA ROPE FOR WATERTOWN ARSENAL, MASS.*

Sample prepared for testing with eye splices at the ends. Splices wet 7 hours before testing. Length between splices about 6 feet.

| Actual. | | Sectional area. | Tensile strength. | | Length of sample. | Weight of sample. | Breaking length. | Parted. |
|---|---|---|---|---|---|---|---|---|
| Circumference. | Diameter. | | Load. | Stress per square inch. | | | | |
| *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Ft.* | *Lb.* | *Ft.* | |
| 9.90 | 3.20 | 8.04 | 49,800 | 6,200 | 19 | 46 | 20,600 | 1 strand at middle of length. |

## TEST 14716.

*TENSILE TEST OF THREE-STRAND MANILA ROPE FOR WATERTOWN ARSENAL, MASS.*

Rope received on P. O. 9427.

Length, circumference, and diameter taken while under stress of 2,600-pound tension. Circumference and diameter taken at three places.

| | Circumference. | Diameter. |
|---|---|---|
| | *In.* | *In.* |
| North end..... | 10.85 | 3.45, 3.42<br>3.47, 3.35 |
| Center..... | 10.90 | 3, 34, 3.35 |
| South end..... | 10.90 | 3.36, 3.48 |

Sample prepared for testing with eye splices at the ends.
Length between ends of splices: 3 ft. 9 in.
Length from inside to inside of eyes: 6 ft. 7 in.
Splices wet 15½ hours before testing.

| Nominal circumference. | Average. | | Sectional area. | Length of sample. | Weight of sample. | Breaking length. | Tensile strength. | | Parted. |
|---|---|---|---|---|---|---|---|---|---|
| | Circumference. | Diameter. | | | | | Load. | Stress per square inch. | |
| *In.* | *In.* | *In.* | *Sq. in.* | *Ft. In.* | *Lb. oz.* | *Ft.* | *Lb.* | *Lb.* | |
| 11 | 11.85 | 3.85 | 11.64 | 18 10 | 6 12 | 20,750 | 73,500 | 6,320 | 1 strand at first tuck. |

## Test 41-11.

### [illegible]

For use in calibrating testing machines at their works and at Brown University, in connection with Bulletin [illegible] Formulæ [illegible]

| Test. | Diameter. | Sectional area. | Elastic limit. | | Tensile strength. | |
|---|---|---|---|---|---|---|
| | | | Load. | Stress per square inch. | Load. | Stress per square inch. |
| | In. | Sq. in. | Lb. | Lb. | Lb. | Lb. |
| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

| Elongation in 8 inches. | | Diameter at fracture. | Contraction of area. | Hardness. | | Appearance of fracture. |
|---|---|---|---|---|---|---|
| Inches. | Per cent. | | | Brinell. | Shore. | |
| | | In. | P. ct. | | | |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | Fine silky. |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | Do. |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | Fine silky, cup and cone. |

# CORDAGE—MANILA ROPE—STEEL WIRE ROPE.

## TEST 14823.

*TENSILE TEST OF STEEL SPECIMENS FOR CALIBRATING EMERY-TESTING MACHINE AT SOUTH BETHLEHEM, PA., FOR W. D. GREETHAM, UNITED STATES NAVY, INSPECTOR OF ORDNANCE.*

| Marks. | Diameter. | Sectional area. | Elastic limit. | | Tensile strength. | |
|---|---|---|---|---|---|---|
| | | | Load. | Stress per square inch. | Load. | Stress per square inch. |
| | *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Lb.* | *Lb.* |
| Z 2768 | 0.5052 | 0.20043 | 8,400 | 41,910 | 13,500 | 67,358 |
| Z 2784 | .5052 | .20043 | 11,700 | 58,379 | 21,400 | 106,760 |

| Marks. | Elongation in 2 inches. | | Elongation of inch sections. | | Diameter at fracture. | Contraction of area. | Appearance of fracture. |
|---|---|---|---|---|---|---|---|
| | *In.* | *P. ct.* | *In.* | *In.* | *In.* | *P. ct.* | |
| Z 2768 | 0.74 | 37.0 | 0.34, | 0.40 | 0.32 | 59.8 | Fine silky. |
| Z 2784 | .44 | 22.0 | .21 | .23 | .39 | 40.3 | Silky. |

## TEST 14823.

*TENSILE TEST OF STEEL SPECIMENS FOR CALIBRATION OF EMERY-TESTING MACHINE AT SOUTH BETHLEHEM, PA., FOR W. D. GREETHAM, UNITED STATES NAVY, INSPECTOR OF ORDNANCE.*

Marks, Z 2764.
Diameter, 0.5047 in.
Sectional area, 0.20012 sq. in.
Gauged length, 2 in.

| Applied loads. | | Elongations. | | Remarks. |
|---|---|---|---|---|
| Load. | Per square inch. | In 2 inches. | Per inch. | |
| *Lb.* | *Lb.* | *In.* | *In.* | |
| 1,020 | 5,094 | 0. | 0. | |
| 2,040 | 10,194 | .0003 | .00015 | |
| 5,100 | 25,485 | .0014 | .00070 | |
| 6,120 | 30,581 | .0018 | .00090 | |
| 6,324 | 31,601 | .0020 | .00100 | |
| 6,528 | 32,620 | .0021 | .00105 | |
| 6,732 | 33,640 | .0022 | .00108 | |
| 6,936 | 34,660 | .0022 | .00110 | |
| 7,140 | 35,679 | .0023 | .00115 | |
| 7,344 | 36,698 | .0025 | .00123 | |
| 7,548 | 37,720 | .0025 | .00125 | |
| 7,752 | 38,736 | .0026 | .00130 | |
| 7,956 | 39,755 | .0028 | .00138 | Elastic limit. |
| 8,160 | 40,778 | .0345 | .01725 | |
| 8,364 | 41,795 | .0362 | .01810 | |
| 8,568 | 42,812 | .0387 | .01935 | |
| 13,566 | 67,789 | ..... | ..... | Tensile strength. |

Elongation of inch sections, 0.36, 0.35 in.
Elongation after fracture, 0.71 in. = 35.5 per cent.
Diameter at fracture, 0.32 in.
Contraction of area, 59.8 per cent.
Position of fracture, at the middle.
Appearance of fracture, fine silky; cup shaped.

## TEST 14853.

*TENSILE TESTS OF A SAMPLE OF THREE-STRAND MANILA ROPE FOR WATERTOWN ARSENAL, MASS.*

Sample prepared for testing with eye splices at the ends. Splices wet 4½ hours before testing. Length between splices = 6 ft.

| P. O. | Nominal size (circumference). | Length of sample. | Weight of sample. | Breaking length. | Circumference. | Diameter. | Sectional area. | Tensile strength (required, 7,000 pounds). | | Parted. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Load. | Stress. | |
| | *In.* | *Ft. in.* | *Lb.* | *Ft.* | *In.* | *In.* | *Sq. in.* | *Lb.* | *Lbs. per sq. in.* | |
| 1457 | 8 | 17 9 | 34 | 19,270 | 9 | 3 | 7.07 | 36,900 | 5,220 | 1 strand 10 in. from end of splice. |

## TEST 14853.

*TENSILE TESTS OF SAMPLES OF THREE-STRAND MANILA ROPE FOR WATERTOWN ARSENAL, MASS.*

Specimens prepared for testing with eye splices at the ends. Splices were wet 4½ hours before testing. Length between splices, 6 ft.

| | P. O. | Nominal size (circumference). | Length of sample. | Weight of sample. | Breaking length. | Circumference. | Diameter. | Sectional area. | Tensile strength (required, 7,000 lbs.). | | Parted. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Load. | Stress per square inch. | |
| | | *In.* | *Ft. in.* | *Lb.* | *Ft.* | *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* | |
| 1 | 1,683 | 8 | 18 1 | 35 | 22,600 | 8.85 | 2.90 | 6.60 | 43,800 | 6,640 | 1 strand in the splice. |
| 2 | 1,686 | 8 | 17 9 | 33 | 18,350 | 8.85 | 2.90 | 6.60 | 34,100 | 5,170 | 1 strand 7 in. from end of splice. |

## TEST 14880.

*TENSILE TESTS OF SAMPLES OF THREE-STRAND MANILA ROPE FOR WATERTOWN ARSENAL, MASS.*

Samples prepared for testing with eye splices at the ends. Splices wet 4½ hours before testing. Length between splices, 6 ft.

| | P. O. | Nominal size (circumference). | Length of sample. | Weight of sample. | Breaking length. | Circumference. | Diameter. | Sectional area. | Tensile strength (required, 7,000 lbs.). Load. | Tensile strength (required, 7,000 lbs.). Stress per square inch. | Parted. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *In.* | *Ft. in.* | *Lb.* | *Ft.* | *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* | |
| 1 | 1,745 | 8 | 18 | 36 | 23,550 | 8.75 | 2.92 | 6.70 | 47,100 | 7,029 | 1 strand 14 in. from end of splice. |
| 2 | 1,745 | 8 | 17 10 | 35 | 20,120 | 8.95 | 2.95 | 6.83 | 39,500 | 5,783 | 1 strand 25 in. from end of splice. |

## TEST 14906.

*TENSILE TEST OF SAMPLE OF THREE-STRAND MANILA ROPE FOR WATERTOWN ARSENAL, MASS.*

Sample prepared for testing with eye splices at the ends. Splices wet 15 hours before testing. Length between splices, 6 feet.

| P. O. | Nominal size (diameter). | Length of sample. | Weight of sample. | Breaking length. | Circumference. | Diameter. | Sectional area. | Tensile strength (required, 7,000 pounds). Load. | Tensile strength (required, 7,000 pounds). Stress per square inch. | Parted. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *In.* | *Ft. in.* | *Lb.* | *Ft.* | *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* | |
| 1457 | 2⅜ | 18 3 | 36 | 26,000 | 9.02 | 2.98 | 6.97 | 51,300 | 7,360 | 1 strand 12 in. from end of splice complies with the requirements. |

## TEST 14936.

*TENSILE TEST OF SAMPLE OF THREE-STRAND MANILA ROPE FOR WATERTOWN ARSENAL, MASS.*

Sample prepared for testing with eye splices at the ends. Splices wet 3½ hours before testing. Length between splices, 6 feet.

| P. O. | Nominal size (diameter). | Length of sample. | Weight of sample. | Breaking length. | Circumference. | Diameter. | Sectional area. | Tensile strength. | | | Parted. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Load. | Required. | Results. | |
| | | | | | | | | | Stress per square inch not less than— | Stress per square inch. | |
| | *In.* | *Ft. in.* | *Lb.* | *Ft.* | *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Lb.* | |
| 1683 | 2⅜ | 18 5 | 34 | 31,500 | 9.00 | 2.97 | 6.93 | 58,300 | 7,000 | 8,412 | One strand 18 in. from end of splice. |
| 1457 | 2⅜ | 18 7 | 38 | 26,300 | 9.10 | 2.99 | 7.02 | 53,900 | 7,000 | 7,678 | Do. |

## TEST 14784.

*TENSILE TEST OF A PIECE OF ⅜-IN. STEEL WIRE ROPE FOR FOUNDRY CRANE AT WATERTOWN ARSENAL, MASS.*

Length of specimen, 60.50 in. = 6 ft. ½ in.
Diameter of rope, 0.38 in.
Number of strands, 6.
Number of wires per strand, 19
Diameter of wire, 0.024 in.
Core or center, hemp.
Tensile strength = 8,990 lb.
Parted, 3 strands at lead grips.

## TEST 14791.

*TENSILE TESTS OF A PIECE OF ½-IN. STEEL ROPE FOR WATERTOWN ARSENAL.*

Represents 410 ft., received January 24, 1912.
Length of specimen, 121 in. = 10 ft. 1 in.
Diameter of rope, 0.47 in.
Number of strands, 8.
Number of wires per strand, 19.
Diameter of wires, 0.019 to 0.029 in.
Core or center, hemp or sisal.

TWO TESTS MADE ON SPECIMEN.

| | Tensile strength. | Parted. |
|---|---|---|
| | *Lb.* | |
| First test..... | 14,700 | 4 strands at edge of lead jaws. |
| Second test..... | 14,900 | Do. |

## TEST 14797.

*TENSILE TEST OF A PIECE OF ½-INCH STEEL WIRE ROPE FOR WATERTOWN ARSENAL, MASS.*

Rope received on P. O. 7454.
Rope prepared for test with closed sockets at the ends.
Length of specimen, 71 in. = 5 ft. 11 in.
Diameter of rope, 0.82 in.
Number of strands, 6.
Number of wires per strand, 41.
Diameter of wires, 4 = 0.014; 37 = 0.036.
Core, hemp.
Tensile strength, 33,400 lb.
Parted, three strands at edge of socket.

## TEST 14830.

### *TENSILE TESTS OF SAMPLES OF STEEL WIRE ROPE FOR WATERTOWN ARSENAL, MASS.*

Rope received from storehouse.
Rope prepared for test with closed sockets at the ends.

DIMENSIONS.

| P. O. | Nominal size (diameter). | Length between sockets. | Diameter of rope. | Number of strands. | Number of wires. | Diameter of wires. | | Core. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Strands. | Inches. | |
| | *In.* | *Ft. in.* | *In.* | | | | | |
| 1563 | ⅜ | 9 7 | 0.39 | 6 | 37 | ..... | 0.017 | Hemp. |
| 1255 | ½ | 9 7 | .53 | 8 | 19 | 6 | .022 | Sisal or hemp. |
| | | | | | | 13 | .030 | |
| 1563 | 9/16 | 9 7½ | .57 | 8 | 19 | ..... | .030 | Do. |
| 1660 | 11/16 | 9 4 | .61 | 6 | 37 | ..... | .028 | Hemp. |
| 7454 | ¾ | 5 5 | .81 | 6 | 41 | 6 | .015 | Do. |
| | | | | | | 35 | .035 | |

| Nominal size. | Tensile strength. | Parted. | Required. |
|---|---|---|---|
| *In.* | *Lb.* | | *Lb.* |
| ⅜ | 12,400 | 6 strands at socket | 10,600 |
| ½ | 18,900 | 7 strands at socket | 19,000 |
| 9/16 | 24,800 | 2 strands 30 in. from end of socket | 24,000 |
| 11/16 | 26,700 | 1 strand 36 in. from end of socket | 24,600 |
| ¾ | 42,200 | 3 strands 13 in. from end of socket | 35,000 |

## TEST 14921.

*TENSILE TESTS OF $\frac{5}{16}$ AND $\frac{1}{4}$ IN. STEEL WIRE ROPE FOR WATERTOWN ARSENAL.*

Rope received from storehouse on P. O. 1910.
Rope prepared for test with closed sockets at the ends.

$\frac{5}{16}$-IN. EXTRA PLIABLE HOISTING ROPE PLOUGH STEEL.

| | Size diameter. | Length between sockets. | Number of strands. | Number of wires per strand. | Diameter of wire. | Core. | Breaking strength. |
|---|---|---|---|---|---|---|---|
| | *In.* | *Ft. in.* | | | *In.* | | |
| Required..... | $\frac{5}{16}$ | ..... | 6 | 37 | ..... | Hemp... | Not less than 12½ net tons. |
| Results..... | 0.61 | 9 8½ | 6 | 37 | 0.027 | ...do.... | 26,700 lb. |

Parted: Two strands 13 in. from end of socket. Complies with requirements.

¼-IN. EXTRA PLIABLE HOISTING ROPE PLOUGH STEEL.

| | Size diameter. | Length between sockets. | Number of strands. | Number of wires per strand. | Diameter of wire. | Core. | Breaking strength. |
|---|---|---|---|---|---|---|---|
| | *In.* | *Ft. in.* | | | *In.* | | |
| Required.... | ¼ | ..... | 6 | 37 | ..... | ..... | Not less than 23 net tons. |
| Results..... | 0.80 | 9 5½ | 6 | 37 | 0.035 | Hemp .. | 45,500 lb. |

Parted: Four strands at end of socket.

## TEST 14777.

*TENSILE TEST OF A MARLINE COVERED WIRE ROPE BRIDLE FOR USE WITH SEACOAST ARTILLERY TARGETS FOR WATERTOWN ARSENAL, MASS.*

The bridle consists of a piece of five-strand, 19 wires per strand, wire rope, covered with marline. Diameter of rope 0.83 in., circumference 2.66 in., measurements over marline covering. Rope was bent around a galvanized thimble 2½ in. diameter by 4 in. long (inside measurements) and the two parts of rope at the small end of thimble served for 2¼ in. with tarred hemp. At the other end the two parts of rope have galvanized thimbles 2½ in. diameter by 4 in. long spliced in. The splices were tapered and served for 10½ in. with tarred hemp. Through the galvanized thimbles were galvanized rings 4 in. inside diameter of ¾ stock. The galvanized rings passed through ¾-in. galvanized eyebolts 15 in. long with washers and nuts at the end.

Length of bridle over all 220 in. = 18 ft. 4 in.

Elongations measured on both parts of bridle on a gauge length of 100 in.

DETAILS OF ELONGATION.

| Applied load. | Stress per square inch. | Elongations on 100 in. lengths. | |
|---|---|---|---|
| | | A. | B. |
| *Lb.* | *Lb.* | *In.* | *In.* |
| 200 | 185 | 0.05 | 0.15 |
| 400 | 369 | .07 | .17 |
| 600 | 555 | .08 | .21 |
| 800 | 740 | .08 | .24 |
| 1,000 | 924 | .14 | .24 |
| 2,000 | 1,845 | .20 | .35 |
| 3,000 | 2,772 | .30 | .45 |
| 4,000 | 3,695 | .40 | .46 |
| 5,000 | 4,610 | .47 | .52 |
| 6,000 | 5,540 | .53 | .63 |
| 7,000 | 6,460 | .61 | .69 |
| 8,000 | 7,395 | .70 | .82 |
| 9,000 | 8,320 | .81 | .90 |
| 10,000 | 9,240 | .90 | 1.00 |
| 11,000 | 11,600 | 1.02 | 1.14 |
| 12,000 | 11,080 | 1.10 | 1.15 |

At 12,900 lb. (11,900 lb. per sq. in.) the galvanized ring on A length fractured.

Appearance of fracture: Fibrous 70 per cent, granular 30 per cent.

### TEST OF ROPE IN BRIDLE.

The test was continued until the rope parted. A fixture passed through the two galvanized thimbles at one end and through the galvanized thimble where the rope was bent around at the other end, or at middle of length of rope. At 36,600 lb. (33,800 lb. per sq. in.) the five strands of rope parted at the middle of rope, or at the bend where the rope was bent around the galvanized thimble.

## TEST 14770.

*TENSILE TEST OF A MANILA ROPE BRIDLE FOR USE WITH SEACOAST ARTILLERY TARGETS FOR WATERTOWN ARSENAL, WATERTOWN MASS.*

The bridle consists of a piece of 3-strand manila rope 4.15 in. circumference, and 1.38 in. diameter, bent around a galvanized thimble 2½ in. diameter by 4 in. long (inside measurements), and the two parts of rope at the small end of thimble served for 2½ in. with tarred hemp.

At the other end the two parts of rope have galvanized thimbles 2½ in. diameter by 4 in. long spliced in. The splices were tapered and sewed for 10½ in. with tarred hemp. Through the galvanized thimbles were galvanized rings 4 in. inside diameter (of ¾ in. stock).

The galvanized rings passed through ¾ in. galvanized eyebolts 15 in. long with washers and nuts at the end.

### DETAILS OF ELONGATIONS.

Sectional area of rope 1.496 sq. in. Total 2.992 sq. in.

Elongations measured on gauge length of 100 in. on both parts of bridle.

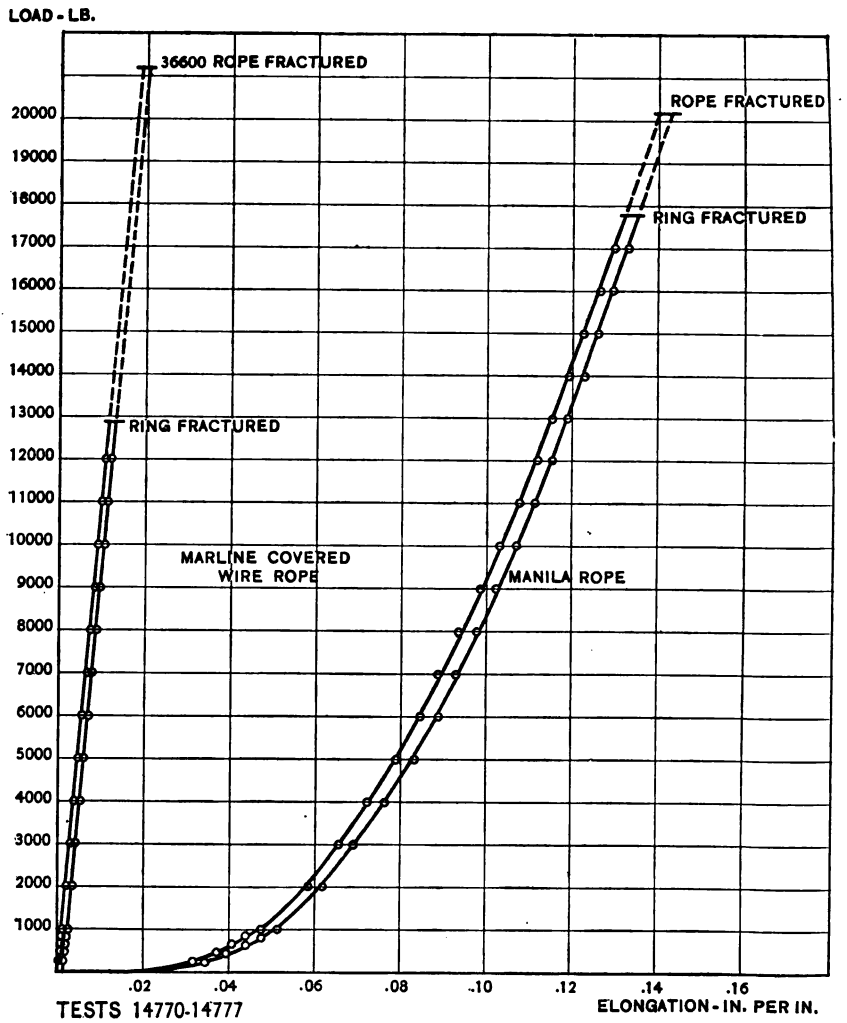
| Applied load. | Stress per square inch. | Elongations on 100-inch lengths. | | | |
|---|---|---|---|---|---|
| | | A. | Per inch. | B. | Per inch. |
| *Lb.* | *Lb.* | *In.* | *In.* | *In.* | *In.* |
| 200 | 67 | 3.15 | 0.0315 | 3.45 | 0.0345 |
| 400 | 134 | 3.70 | .0370 | 3.95 | .0395 |
| 600 | 200 | 4.05 | .0405 | 4.40 | .0440 |
| 800 | 267 | 4.45 | .0445 | 4.80 | .0480 |
| 1,000 | 334 | 4.85 | .0485 | 5.15 | .0515 |
| 2,000 | 668 | 5.85 | .0585 | 6.20 | .0620 |
| 3,000 | 1,003 | 6.55 | .0655 | 6.90 | .0690 |
| 4,000 | 1,336 | 7.20 | .0720 | 7.60 | .0760 |
| 5,000 | 1,668 | 7.90 | .0790 | 8.30 | .0830 |
| 6,000 | 2,002 | 8.45 | .0845 | 8.85 | .0885 |
| 7,000 | 2,340 | 8.85 | .0885 | 9.25 | .0925 |
| 8,000 | 2,674 | 9.35 | .0935 | 9.75 | .0975 |
| 9,000 | 3,010 | 9.85 | .0985 | 10.20 | .1020 |
| 10,000 | 3,340 | 10.25 | .1025 | 10.70 | .1070 |
| 11,000 | 3,673 | 10.70 | .1070 | 11.10 | .1110 |
| 12,000 | 4,010 | 11.15 | .1115 | 11.50 | .1150 |
| 13,000 | 4,340 | 11.50 | .1150 | 11.85 | .1185 |
| 14,000 | 4,675 | 11.85 | .1185 | 12.20 | .1220 |
| 15,000 | 5,010 | 12.15 | .1215 | 12.50 | .1250 |
| 16,000 | 5,340 | 12.55 | .1255 | 12.85 | .1285 |
| 17,000 | 5,670 | 12.90 | .1290 | 13.20 | .1320 |
| 17,800 | 5,940 | ..... | ..... | [1] | ..... |

[1] Galvanized rign on B length fractured at the weld.

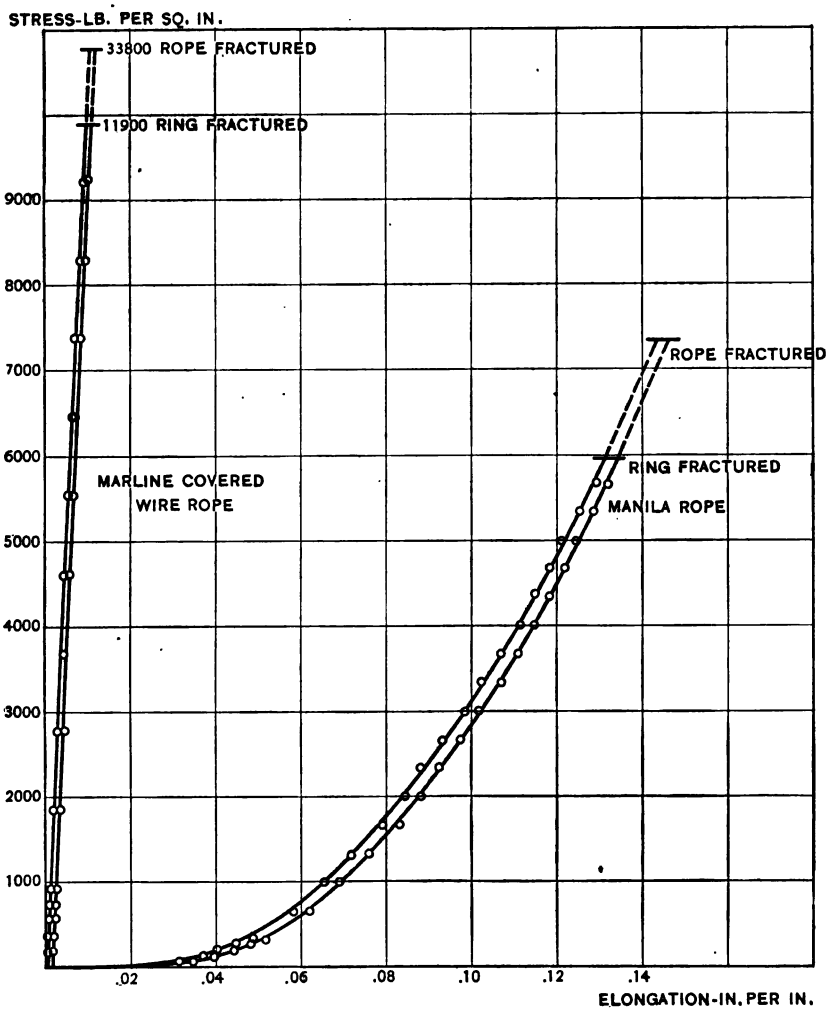
### TEST OF ROPE IN BRIDLE.

The test was continued until the rope parted. A fixture was passed through the two galvanized thimbles at one end, and through the galvanized thimble where the rope was bent around at the other end or at middle of length of rope.

At 20,200 lb. (7,345 lb. per sq. in.) two strands of rope parted at middle of length of rope, or at the bend where the rope bent around the galvanized thimble.




TENSILE TESTS OF BRIDLES
FOR SEACOAST ARTILLERY TARGETS




TESTS NO'S 14770-14777

TENSILE TESTS OF BRIDLES FOR SEACOAST ARTILLERY TARGETS.

## TEST 14951.

*TENSILE TEST OF A MARLINE-COVERED STEEL WIRE ROPE BRIDLE FOR USE WITH SEACOAST ARTILLERY TARGETS FOR WATERTOWN ARSENAL. EX. O. 7829.*

[1 piece 36 ft., ¾ in. diameter, 6 x 19. Crucible steel.]

The bridle consists of a piece of six-strand, 19 wires per strand, steel wire rope, covered with marline. Diameter of rope, 0.84 in. Circumference, 2.68 in. Measurements over marline covering.

The rope was bent around a galvanized thimble 2½ in. diameter by 4 in. long (inside measurements), and the two parts of rope at the small end of thimble served for 2 in. with tarred hemp. At the other end the two parts of rope have galvanized thimbles 2½ in. diameter by 4 in. long spliced in. These splices were tapered and served for 10 in. with tarred hemp. At this end the galvanized thimbles pass through the eye of dropped forged hooks. Length of hooks over all: 10½ in. Diameter of body of hook: 1.50 in.

Length of bridle over all: 202 in. = 16 ft. 10 in.

Elongation measured on both parts of bridle on a gauge length of 100 in. A and B.

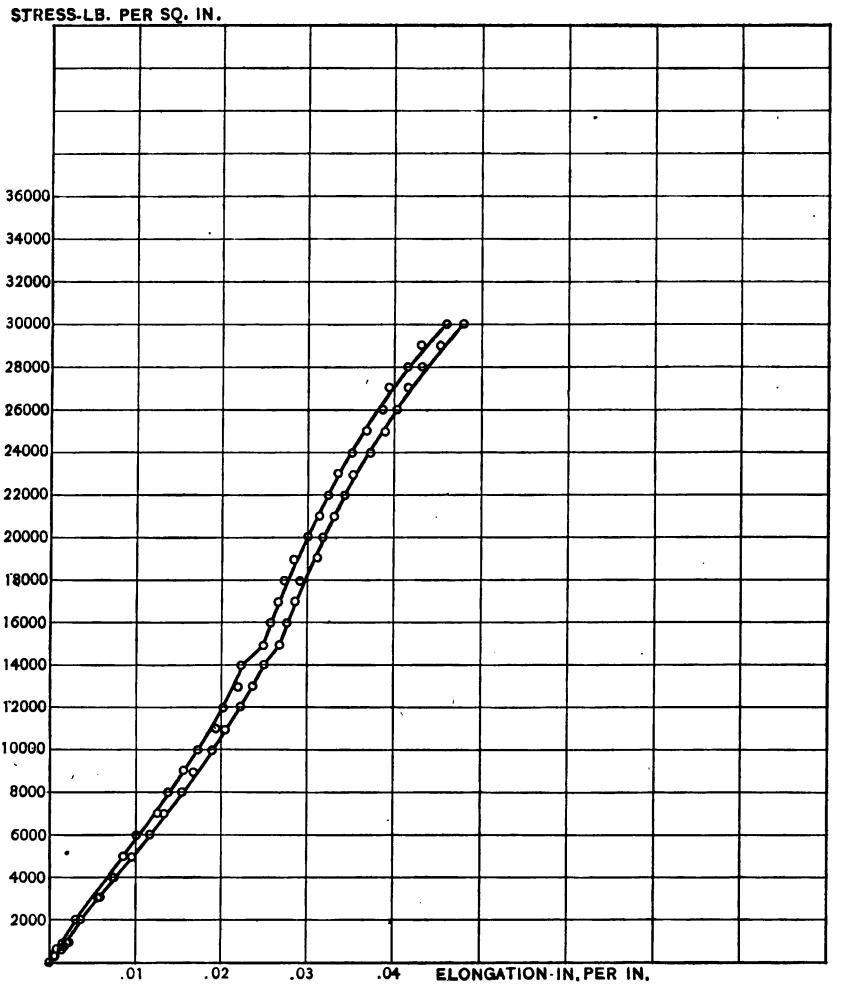
Sectional area: 0.5541 sq. in. Total: 1.1082 sq. in.

DETAILS OF ELONGATIONS.

| Applied load. | Stress per square inch. | Elongations on 100-inch length. | |
|---|---|---|---|
| | | A. | B. |
| *Lb.* | *Lb.* | *In.* | *In.* |
| 111 | 200 | 0. | 0. |
| 222 | 400 | .07 | .05 |
| 333 | 600 | .13 | .06 |
| 443 | 800 | .15 | .10 |
| 554 | 1,000 | .18 | .15 |
| 1,108 | 2,000 | .34 | .28 |
| 1,663 | 3,000 | .56 | .53 |
| 2,217 | 4,000 | .73 | .70 |
| 2,771 | 5,000 | .96 | .84 |
| 3,325 | 6,000 | 1.16 | 1.02 |
| 3,879 | 7,000 | 1.33 | 1.25 |
| 4,433 | 8,000 | 1.57 | 1.38 |
| 4,972 | 9,000 | 1.69 | 1.56 |
| 5,541 | 10,000 | 1.90 | 1.74 |
| 6,096 | 11,000 | 2.08 | 1.97 |
| 6,649 | 12,000 | 2.23 | 2.05 |
| 7,204 | 13,000 | 2.40 | 2.24 |
| 7,758 | 14,000 | 2.52 | 2.26 |
| 8,312 | 15,000 | 2.71 | 2.54 |
| 8,860 | 16,000 | 2.81 | 2.62 |
| 9,421 | 17,000 | 2.86 | 2.70 |
| 9,974 | 18,000 | 2.95 | 2.75 |
| 10,529 | 19,000 | 3.13 | 2.85 |
| 11,083 | 20,000 | 3.22 | 3.02 |
| 11,637 | 21,000 | 3.31 | 3.14 |
| 12,192 | 22,000 | 3.44 | 3.25 |
| 12,747 | 23,000 | 3.54 | 3.36 |
| 13,300 | 24,000 | 3.73 | 3.51 |
| 13,855 | 25,000 | 3.89 | 3.67 |
| 14,409 | 26,000 | 4.04 | 3.86 |
| 14,962 | 27,000 | 4.17 | 3.95 |
| 15,517 | 28,000 | 4.34 | 4.17 |
| 16,071 | 29,000 | 4.55 | 4.33 |
| 16,624 | 30,000 | 4.81 | 4.60 |
| 16,624 | 30,000 | ..... | (1) |

[1] Tensile strength.

At 16,624 lb. = 30,000 lb. per sq. in. after the elongation on parts A and B had been taken, the six strands of rope parted at the middle of the length of rope, or at the bend where the rope was bent around the galvanized thimble. At the other end two strands parted at the end of the serving on part A.




TEST NO. 14951*a*.

TENSILE TESTS OF MARLINE COVERED STEEL WIRE ROPE FOR SEACOAST ARTILLERY TARGETS.

⅜ IN. DIA. 6 STRAND OF 19 WIRE EACH CRUCIBLE STEEL

*TENSILE TEST OF A MARLINE COVERED STEEL WIRE ROPE BRIDLE FOR USE WITH SEACOAST ARTILLERY TARGETS FOR WATERTOWN ARSENAL, MASS.*

[1 piece 36 ft. long, ½ in. diameter. 5 x 19. Crucible Steel.]

The bridle consists of a piece of five-strand, 19 wires per strand, steel wire rope covered with marline. Diameter of rope 0.83 in. Circumference, 2.58 in. Measurements over marline covering.

The rope was bent around a galvanized thimble 2½ in. diameter by 4 in. long (inside measurements), and the two parts of rope at the small end of thimble served for 2 in. with tarred hemp.

At the other end the two parts of rope have galvanized thimbles 2½ in. diameter by 4 in. long, spliced in. The splices were tapered and served for 10 in. with tarred hemp. At this end the galvanized thimbles pass through the eye of dropped-forged hooks. Length of hooks over all, 10.25 in.; diameter of body of hooks, 1.50 in.

Length of bridle over all, 203 in. = 16 ft. 11 in.

Elongation measured on both parts of bridle on a gauge length of 100 in. A and B.

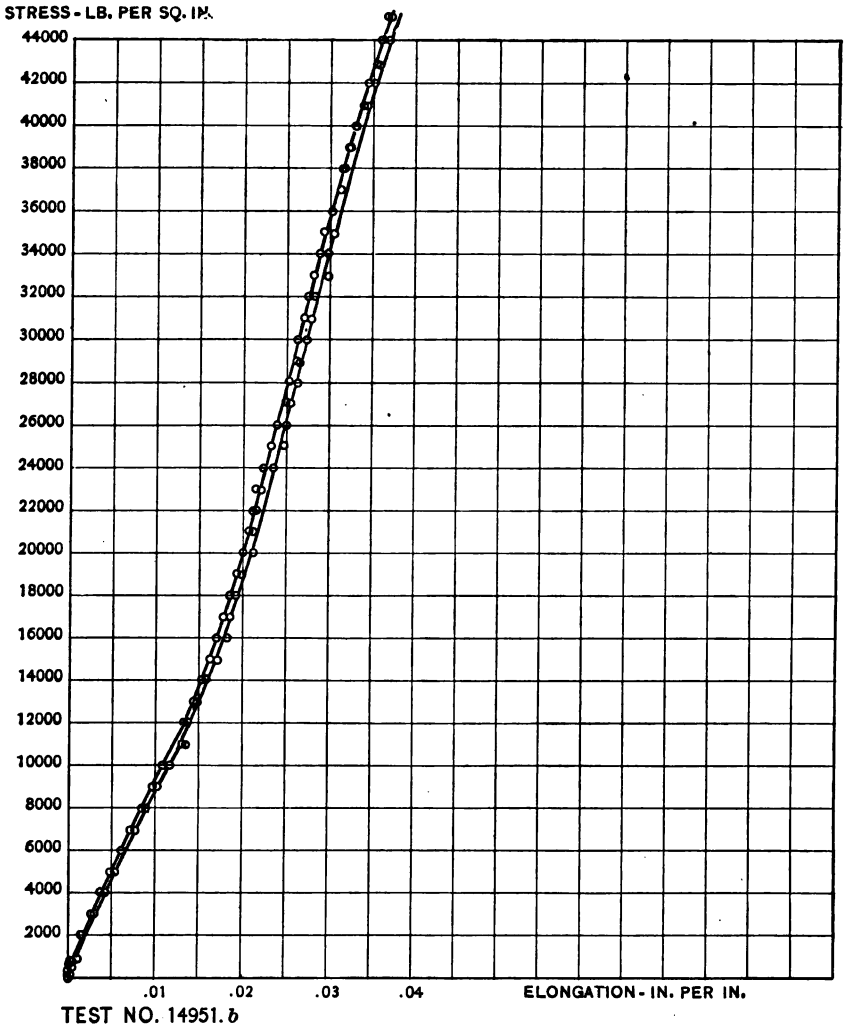
Sectional area of rope, 0.5410 sq. in. Total, 1.082 sq. in.

DETAILS OF ELONGATION.

| Applied load. | Stress per square inch. | Elongations on 100-inch length. | |
|---|---|---|---|
| | | A. | B. |
| *Lb.* | *Lb.* | *In.* | *In.* |
| 108 | 200 | 0. | 0. |
| 216 | 400 | .01 | .05 |
| 325 | 600 | .05 | .02 |
| 433 | 800 | .09 | .05 |
| 541 | 1,000 | .10 | .09 |
| 1,082 | 2,000 | .21 | .15 |
| 1,623 | 3,000 | .29 | .27 |
| 2,164 | 4,000 | .43 | .39 |
| 2,705 | 5,000 | .54 | .51 |
| 3,246 | 6,000 | .64 | .60 |
| 3,787 | 7,000 | .80 | .73 |
| 4,328 | 8,000 | .90 | .88 |
| 4,869 | 9,000 | 1.04 | .99 |
| 5,411 | 10,000 | 1.19 | 1.10 |
| 5,952 | 11,000 | 1.38 | 1.32 |
| 6,493 | 12,000 | 1.40 | 1.37 |
| 7,033 | 13,000 | 1.53 | 1.47 |
| 7,574 | 14,000 | 1.60 | 1.53 |
| 8,115 | 15,000 | 1.75 | 1.65 |
| 8,656 | 16,000 | 1.82 | 1.71 |
| 9,197 | 17,000 | 1.89 | 1.82 |
| 9,737 | 18,000 | 1.95 | 1.88 |
| 10,279 | 19,000 | 2.04 | 1.96 |
| 10,820 | 20,000 | 2.13 | 2.04 |
| 11,361 | 21,000 | 2.15 | 2.10 |
| 11,902 | 22,000 | 2.23 | 2.15 |
| 12,444 | 23,000 | 2.29 | 2.19 |
| 12,984 | 24,000 | 2.38 | 2.29 |
| 13,526 | 25,000 | 2.50 | 2.36 |
| 14,066 | 26,000 | 2.54 | 2.45 |
| 14,607 | 27,000 | 2.58 | 2.52 |
| 15,149 | 28,000 | 2.66 | 2.57 |
| 15,690 | 29,000 | 2.69 | 2.65 |
| 16,230 | 30,000 | 2.76 | 2.66 |
| 16,771 | 31,000 | 2.84 | 2.75 |
| 17,312 | 32,000 | 2.87 | 2.79 |
| 17,854 | 33,000 | 3.00 | 2.86 |
| 18,394 | 34,000 | 3.01 | 2.93 |
| 18,936 | 35,000 | 3.08 | 2.96 |
| 19,476 | 36,000 | 3.07 | 3.09 |
| 20,018 | 37,000 | 3.19 | 3.15 |
| 20,558 | 38,000 | 3.25 | 3.18 |
| 21,098 | 39,000 | 3.30 | 3.24 |
| 21,639 | 40,000 | 3.39 | 3.33 |
| 22,180 | 41,000 | 3.51 | 3.44 |
| 22,721 | 42,000 | 3.59 | 3.50 |
| 23,262 | 43,000 | 3.66 | 3.60 |
| 23,803 | 44,000 | 3.74 | 3.65 |
| 24,344 | 45,000 | 3.80 | 3.70 |
| 24,885 | 46,000 | 3.93 | 3.80 |
| 25,000 | 46,210 | (1) | (1) |

[1] Tensile strength.

At 25,000 lb. = 62,210 lb. per sq. in. four strands of the rope parted at end of serving where the galvanized thimble was spliced into rope or at hook end on part A.




TENSILE TEST OF MARLINE COVERED STEEL WIRE ROPE FOR SEACOAST ARTILLERY TARGETS.
½ IN. 5 STRANDS OF 19 WIRES EACH, CRUCIBLE STEEL.

*TENSILE TEST OF A MARLINE-COVERED STEEL WIRE ROPE BRIDLE FOR USE WITH SEACOAST ARTILLERY TARGETS FOR WATERTOWN ARSENAL, MASS.*

[1 piece 36 ft., ½ in. diam. 5 x 19. Plow Steel.]

The bridle consists of a piece of five strands, 19 wires per strand. steel wire rope, covered with marline. Diameter of rope, 0.82 in, Circumference of rope, 2.58 in. measured over marline covering. The rope was bent around a galvanized thimble 2½ in. diameter by 4 in. long (inside measurements), and the two parts of rope at the small d of thimble served for 2 in. with tarred hemp.

At the other end the two parts of rope have galvanized thimbles 2½ in. diameter by 4 in. long, spliced in. The splices were tapered and served for 10 in. with tarred hemp. At this end the galvanized thimbles pass through the eye of dropped forged hooks. Length of hooks over all, 10¼ in. Diameter of body of hooks, 1.50 in.

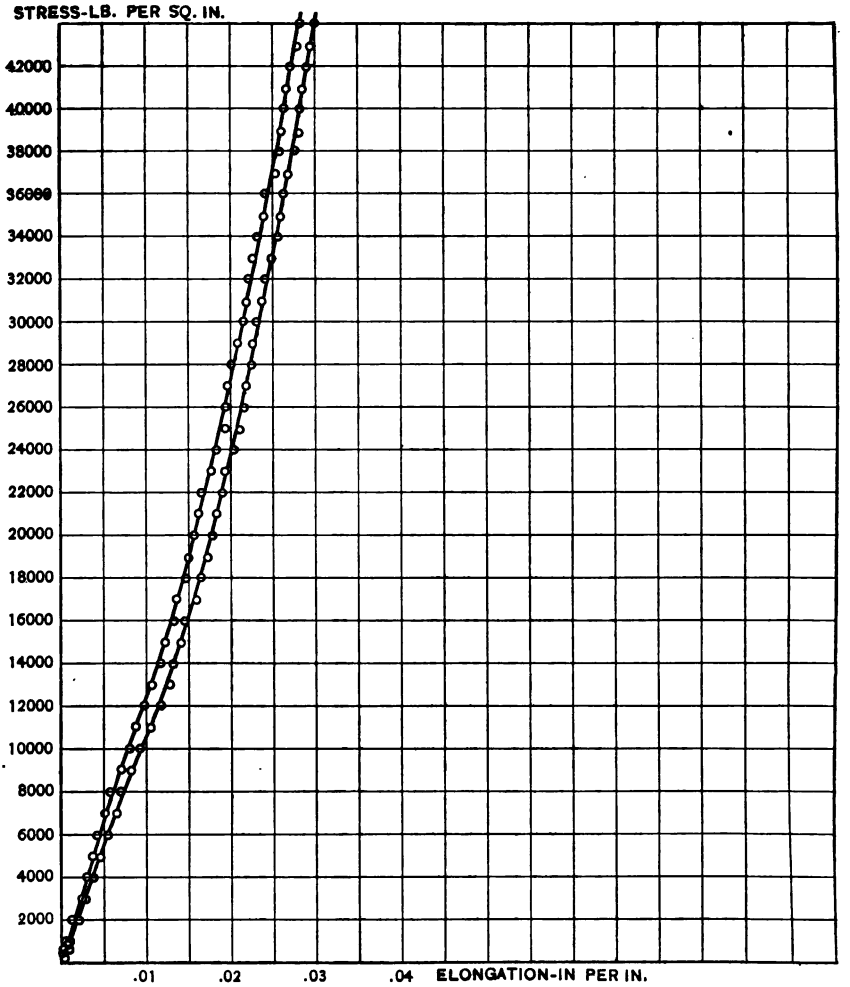
Length of bridle over all, 201 in. = 16 ft. 11 in. Elongations measured on both parts of bridle on a gage length of 100 in. A and B. Sectional area of rope: 0.5281 sq. in. Total, 1.0562 sq. in.

DETAILS OF ELONGATIONS.

| Applied loads. | Stress per square inch. | Elongation on 100-inch length. | |
|---|---|---|---|
| | | A. | B. |
| *Lb.* | *Lb.* | *In.* | *In.* |
| 106 | 200 | 0. | 0. |
| 211 | 400 | 0. | 0. |
| 317 | 600 | .05 | .04 |
| 422 | 800 | .07 | .06 |
| 528 | 1,000 | .07 | .05 |
| 1,061 | 2,000 | .13 | .19 |
| 1,584 | 3,000 | .25 | .27 |
| 2,112 | 4,000 | .31 | .37 |
| 2,640 | 5,000 | .35 | .44 |
| 3,168 | 6,000 | .42 | .53 |
| 3,696 | 7,000 | .51 | .65 |
| 4,225 | 8,000 | .58 | .70 |
| 4,753 | 9,000 | .71 | .82 |
| 5,281 | 10,000 | .80 | .93 |
| 5,808 | 11,000 | .87 | 1.02 |
| 6,337 | 12,000 | .96 | 1.15 |
| 6,864 | 13,000 | 1.05 | 1.25 |
| 7,393 | 14,000 | 1.15 | 1.30 |
| 7,920 | 15,000 | 1.21 | 1.40 |
| 8,449 | 16,000 | 1.31 | 1.44 |
| 8,977 | 17,000 | 1.35 | 1.57 |
| 9,505 | 18,000 | 1.46 | 1.63 |
| 10,033 | 19,000 | 1.50 | 1.70 |
| 10,561 | 20,000 | 1.56 | 1.77 |
| 11,090 | 21,000 | 1.61 | 1.83 |
| 11,618 | 22,000 | 1.66 | 1.89 |
| 12,146 | 23,000 | 1.76 | 1.93 |
| 12,674 | 24,000 | 1.82 | 2.02 |
| 13,202 | 25,000 | 1.92 | 2.09 |
| 13,731 | 26,000 | 1.93 | 2.15 |
| 14,259 | 27,000 | 1.97 | 2.18 |
| 14,787 | 28,000 | 2.02 | 2.25 |
| 15,315 | 29,000 | 2.08 | 2.27 |
| 15,843 | 30,000 | 2.15 | 2.30 |
| 16,371 | 31,000 | 2.19 | 2.37 |
| 16,900 | 32,000 | 2.20 | 2.41 |
| 17,429 | 33,000 | 2.26 | 2.48 |
| 17,956 | 34,000 | 2.32 | 2.56 |
| 18,483 | 35,000 | 2.40 | 2.60 |
| 19,011 | 36,000 | 2.43 | 2.62 |
| 19,539 | 37,000 | 2.53 | 2.68 |
| 20,068 | 38,000 | 2.58 | 2.75 |
| 20,595 | 39,000 | 2.60 | 2.80 |
| 21,123 | 40,000 | 2.62 | 2.82 |
| 21,651 | 41,000 | 2.67 | 2.85 |
| 22,180 | 42,000 | 2.70 | 2.91 |
| 22,708 | 43,000 | 2.81 | 2.95 |
| 23,236 | 44,000 | 2.82 | 3.00 |
| 23,764 | 45,000 | 2.85 | 3.04 |
| 24,292 | 46,000 | 2.90 | 3.13 |
| 24,820 | 47,000 | 2.95 | 3.18 |
| 25,348 | 48,000 | 3.02 | 3.21 |
| 25,876 | 49,000 | 3.07 | 3.30 |
| 26,403 | 50,000 | (1) | (1) |

[1] Tensile strength.

At 26,403 lb. = 50,000 lb. per sq. in., two strands of the rope parted at end of serving where galvanized thimble was spliced into rope, or at hook end on part B.




TEST NO. 14951 *c*

TENSILE TESTS OF MARLINE COVERED STEEL WIRE ROPE FOR SEACOAST ARTILLERY TARGETS, ½-IN. DIA. 5 STRANDS OF 19 WIRES EACH, PLOW STEEL

# METALLOGRAPHIC EXAMINATIONS.

*REPORT ON A FRACTURED NUT.*

1. A section was cut out from the nut and two sides were polished for microscopic examination. The structure shows very low carbon, a normal granular appearance indicating satisfactory heat treatment, and a fairly large amount of slag. The amount of slag is greater in the region of the fracture.

2. There evidently had been a seam in the metal which was produced at the time of rolling. The unusual amount of slag at this point prevented complete cementing of the surfaces, and it gave way along the seam when force was applied.

*REPORT OF THE EXAMINATION OF BROKEN STEEL EXTRACTOR, BELONGING TO A 15-PDR. GUN, MODEL 1903.*

The photograph represents the structure of the metal at point near the point of rupture. No differences could be detected in the microstructure of the metal at various points near the break by careful examination.

Scleroscope tests indicate a similar uniformity in the metal. The average hardness was 35.4, as indicated by the Shore instrument.

The structure suggests that the metal had been oil hardened and subsequently annealed, but it would be impossible to make a positive statement to this effect. The dark spots are not slag as might be thought, but are the remains of scratches which are brought out by the high magnification.

*REPORT OF THE RESULTS OF AN EXAMINATION OF A SAMPLE TAKEN FROM A BROKEN EQUALIZING PIPE FROM 12-INCH MORTAR CARRIAGE, MODEL OF 1896 MI, NO. 164.*

The polished section showed almost entire freedom from slag. The etched specimen showed indications of low carbon and normal structure, with the single exception that there were evidences of cold work. The ferrite granules were elongated in the direction of the rolling. Such cold work would make the metal more brittle and hard than would ordinarily be found in an annealed pipe.

CHEMICAL ANALYSIS.

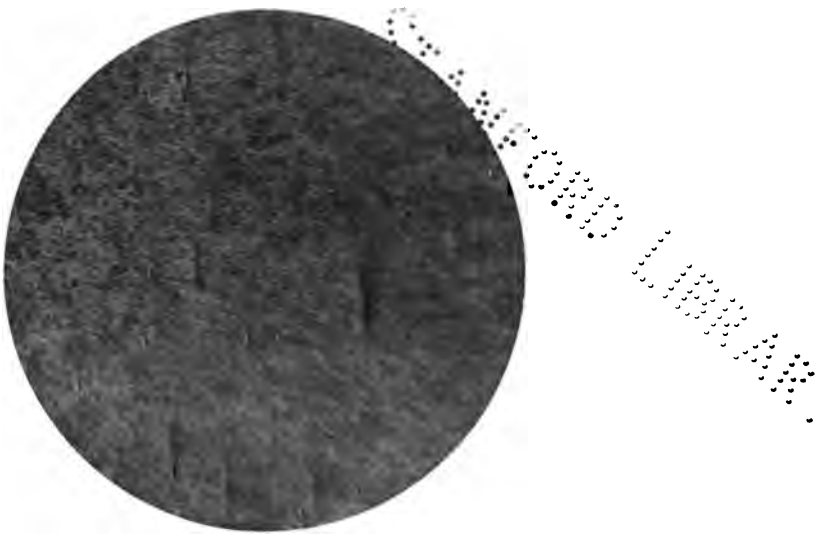
| | |
|---|---|
| Carbon | 0.20 |
| Manganese | .49 |
| Silicon | .005 |
| Sulphur | .019 |
| Phosphorus | .010 |

PHYSICAL TEST.

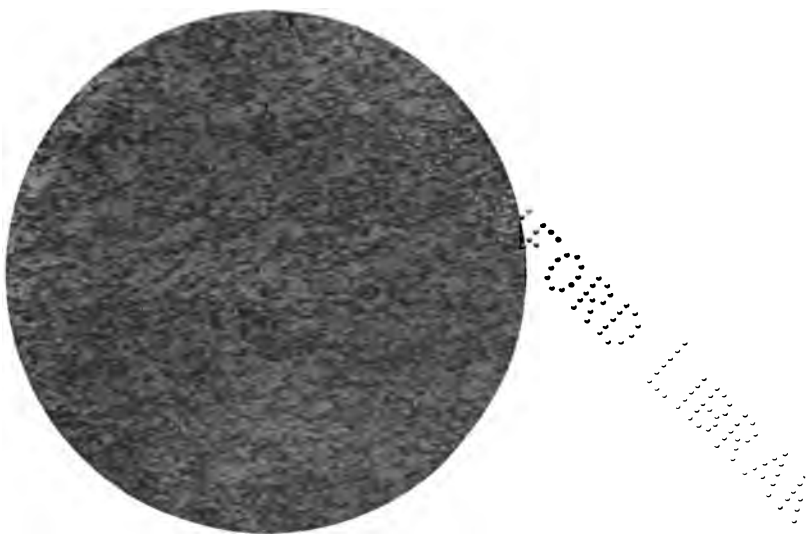
[Mean of two tests.]

Elastic limit, 64,800 lb. per sq. in.
Tensile strength, 74,200 lb. per sq. in.
Elongation in 6 in., 9.15 per cent.
Contraction of area, 51.9 per cent.

15-POUNDER EXTRACTOR. GUN MODEL 1903, No. 25. X 200.

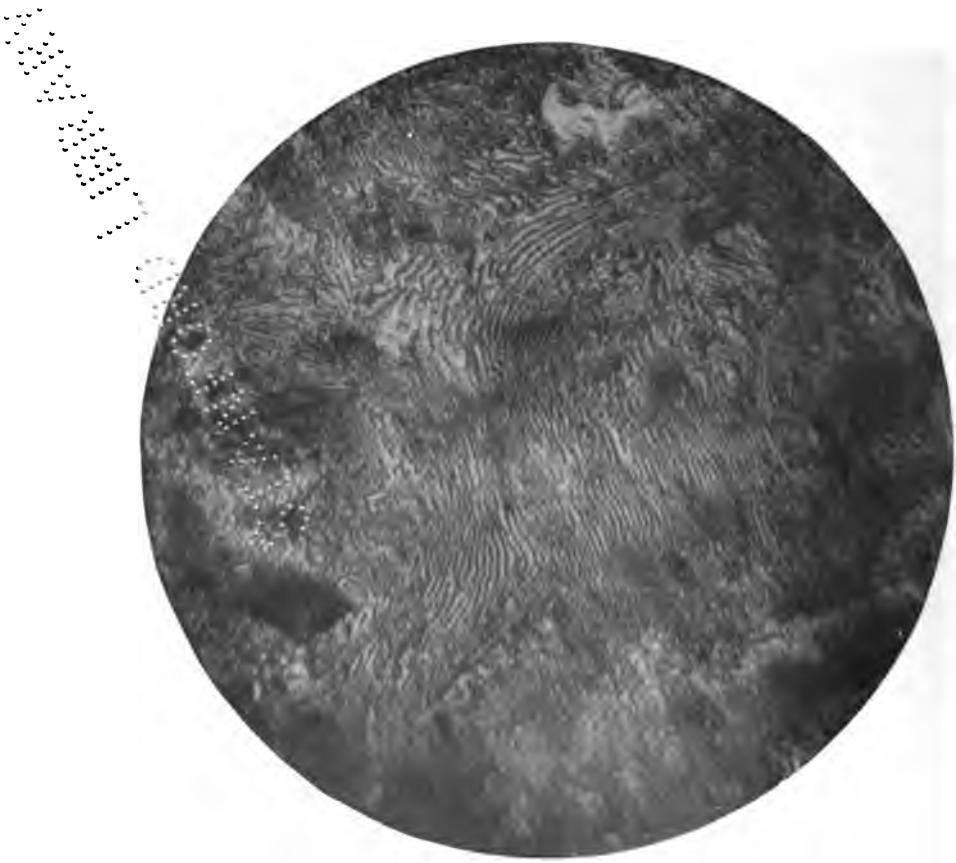


Property of Cornell University



BROKEN EQUALIZING PIPE FROM 12 IN M. C., MOD. 1896M1. X 50.

Approved for Public Release



SPECIMEN 6684-330 A.

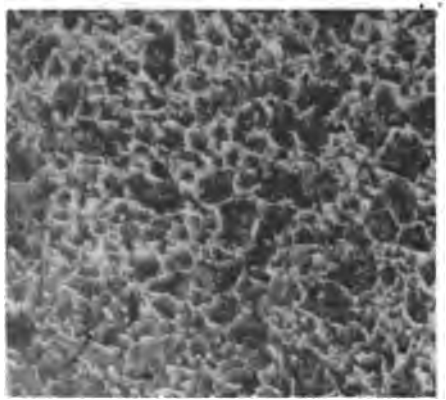
CLASSIFIED DOCUMENT

Elevating Screw No. 3.

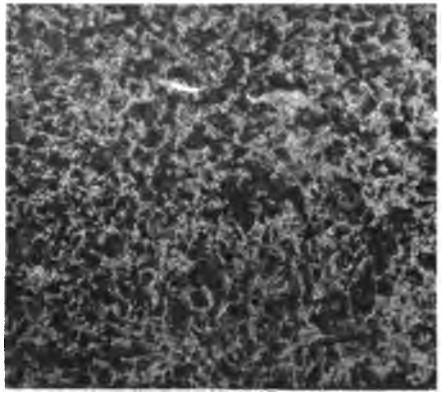
PHOTOGRAPH FROM COLLAR. X 100.

PHOTOGRAPH FROM NEAR COLLAR. X 100.

Elevating Screw No. 4.

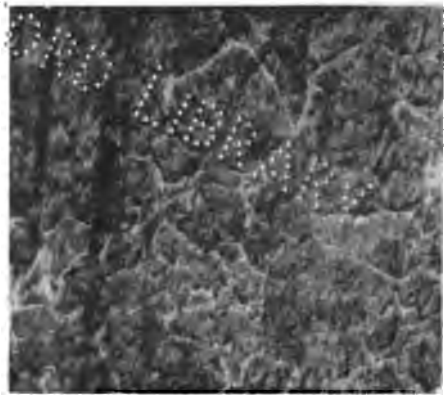


PHOTOGRAPH FROM COLLAR. X 100.

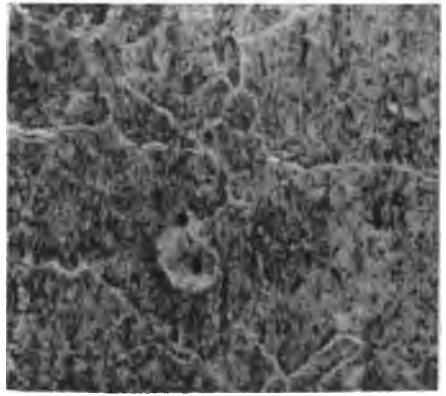


PHOTOGRAPH FROM NEAR COLLAR. X 100.

Elevating Screw No. 5.

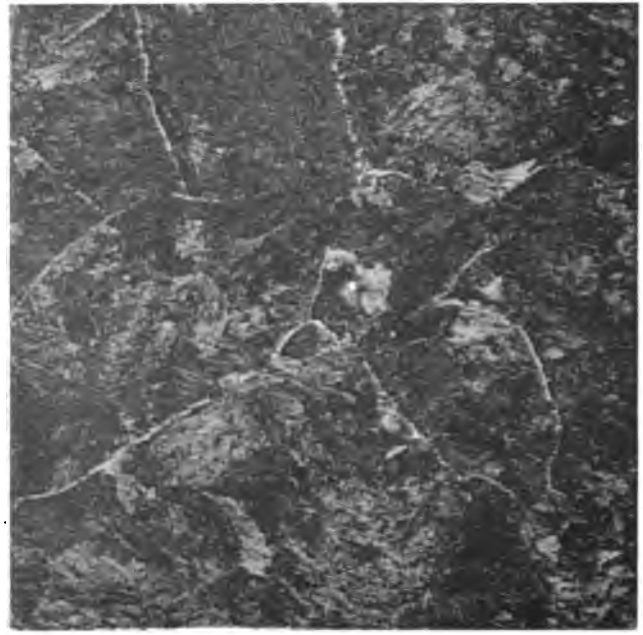


PHOTOGRAPH FROM COLLAR. X 100.



PHOTOGRAPH FROM NEAR COLLAR. X 100.

CANCELLED



MICROPHOTOGRAPHS OF BROKEN ELEVATING SCREW NO. 1, FOR 14 IN. DISAPPEARING CARRIAGE, L. F. MODEL, 1907.

HELIOTYPE CO. BOSTON

*RESULTS OF AN EXAMINATION OF SPECIMENS CUT FROM THE COLLAR AND NEAR THE COLLAR OF THE ELEVATING SCREW No. 1, FOR 14-INCH DISAPPEARING CARRIAGE, L. F., MODEL 1907.*

The two specimens show similar characteristics and both give evidence of having been improperly heat treated. The metal has undoubtedly been heated to a very high temperature and has been allowed to cool slowly. This is indicated by the crystallization which has taken place within each grain, by the unusual size of the grain itself, and by the presence of well-laminated perlite. The photographs show clearly the unusual grain size, and the crystallization of the grain. There is no evidence in either specimen of the metal having received any forging.

The failure of this metal was due to the improper heat treatment which it received.

*REPORT OF THE RESULTS OF THE MICROSCOPICAL EXAMINATION OF ELEVATING SCREWS NOS. 3, 4, AND 5.*

1. Examination of screw No. 3 shows an unusually coarse structure, indicating that the metal has been heated to a high temperature and has cooled slowly from this temperature. There is no evidence of the metal having been forged. The photographs submitted herewith show the coarsely granular structure.

2. Screw No. 5 also shows a granular structure, but the granules are not so large as in No. 3. In this screw there is evidence of the metal having been forged. The structure, however, is not so fine as might be desired. A comparison of photographs of No. 5 and No. 3 shows the differences in structure.

3. Screw No. 4 shows a fairly fine-grained structure, and shows evidence of better heat treatment than either of the other two screws. It also bears evidence of forging down to near the critical temperature.

*REPORT OF THE MICROSCOPICAL EXAMINATION OF STEEL SPECIMEN MARKED "6684-550 A."*

On etching the polished cross section of the bar there was developed a distinctly crystalline macrostructure, which was distributed over the field. There was also made evident a pronounced central area nearly square in section, which was slightly more crystalline than the outer area. This can be accounted for by assuming that the central area was allowed to cool more slowly than the exterior and that the exterior received more work than the interior. The square shape of the inner area would indicate that the bar was originally rectangular in cross section and that it had been forged into the circular cross section.

The photograph shows the characteristic microstructure. Such well-developed laminated perlite is an excellent indication that the metal had been heated to a very high temperature and allowed to cool extremely slowly.

Elastic limit, 39,400 lb. per square inch.

Tensile strength, 77,900 lb. per square inch.

Elongation in 8 in., 1.75 per cent.

Contraction of area, broke in threaded section.

# RUBBER.

## TEST 14679.

*TENSILE TESTS OF COVERING RUBBER FOR WATERTOWN ARSENAL, MASS.*

Length of specimen, 10 in.

Elongations taken on gauge length of 2 in.

| Width. | Thickness. | Sectional area. | Tensile strength. | | Elongation in 2 inches. | | Marks. |
|---|---|---|---|---|---|---|---|
| | | | Load. | Stress per square inch. | Inches. | Per cent. | |
| *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* | | | |
| 0.95 | 0.45 | 0.4275 | 273 | 638 | 3 | 150 | Roll 1. |
| .90 | .45 | .405 | 300 | 740 | 2.65 | 132.5 | Roll 2. |

## TEST 14689.

*TENSILE TEST OF RUBBER FOR WATERTOWN ARSENAL, MASS.*

| Marks. | Width. | Thickness. | Sectional area. | Tensile strength. | |
|---|---|---|---|---|---|
| | | | | Load. | Stress per square inch. |
| | *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* |
| Red foundation rubber | 0.83 | 0.45 | 0.374 | 310 | 830 |
| Covering rubber | .92 | .49 | .450 | 520 | 1,160 |

| Marks. | Elongation in 2 inches. | | Remarks. |
|---|---|---|---|
| | Inches. | Per cent. | |
| Red foundation rubber, CTA, 3189-19485, F 202B, May 29, 1911. | 6.7 | 335 | Fracture in center of gauge length. |
| Covering rubber, CTA, 3189-19485, F 202C, May 29, 1911. | 1.0 | 50 | Fracture ¼ in. inside gauge mark. |

## TEST 14707.

*TENSILE TESTS OF RUBBER FOR WATERTOWN ARSENAL, MASS.*

| Marks. | Width. | Thickness. | Sectional area. | Tensile strength. | | Elongation in 2 inches. | | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | | | Load. | Stress per square inch. | Inches. | Per cent. | |
| | *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* | | | |
| Red foundation rubber. | 0.90 | 0.44 | 0.396 | 267 | 674 | 4.75 | 237.5 | Fractured near center of specimens. |
| Covering rubber. | 1.06 | .50 | .53 | 520 | 981 | 1.60 | 80.0 | Fractured near first mark on specimens. |

## TEST 14731.

*TENSILE TEST OF COVERING RUBBER FOR WATERTOWN ARSENAL.*

| Marks. | Width. | Thickness. | Sectional area. | Tensile strength. | | Elongation in 2 inches. | | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | | | | Load. | Stress per square inch. | Inches. | Per cent. | |
| | *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* | | | |
| ½ covering, rubber. | 0.92 | 0.5 | 0.46 | 255 | 554 | 0.85 | 42.5 | Fractured on gauge mark. |
| 1/16 covering, rubber. | .90 | .63 | .567 | 295 | 520 | 1.00 | 50.0 | Do. |

## TEST 14898.

*TENSILE TESTS OF COVERING RUBBER FOR WATERTOWN ARSENAL MASS.*

Length of samples, 10.25 inches. Elongations taken on gauged length of 2 inches.

| Marks. | Width. | Thickness. | Sectional area. | Tensile strength required, 600 pounds. | | Required elongation. | Elongation in 2 inches. | |
|---|---|---|---|---|---|---|---|---|
| | | | | Load. | Stress per square inch. | | Inches. | Per cent. |
| Covering rubber: | *In.* | *In.* | *Sq. in.* | *Lb.* | *Lb.* | | | |
| 1/16-inch..... | 0.99 | 0.54 | 0.534 | 461 | 863 | Not less than 75 per cent nor more than 150 per cent. | 4.50 | 225 |
| ¼-inch..... | .99 | .54 | .534 | 430 | 805 | ..... | 4.40 | 220 |

## TEST 14928.

*TENSILE TEST OF COVERING RUBBER FOR WATERTOWN ARSENAL, MASS.*

Rubber received on P. O. 1819.
Length of sample, 10 inches. Elongations taken on gauged length of 2 inches.

| Kind. | Dimensions. | | Sectional area. | Tensile strength. | | Elongation in 2 inches. | |
|---|---|---|---|---|---|---|---|
| | Width. | Thickness. | | Load. | Stress per square inch. | Inches. | Per cent. |
| Covering, ½-inch..... | *In.* 1.06 | *In.* 0.56 | *Sq. in.* 0.594 | *Lb.* 597 | *Lb.* 1,005 | 4.40 | 220 |

Required: Tensile strength of not less than 600 pounds per square inch. Elongation in 2 inches of not less than 75 nor more than 150 per cent.

## TEST 14963.

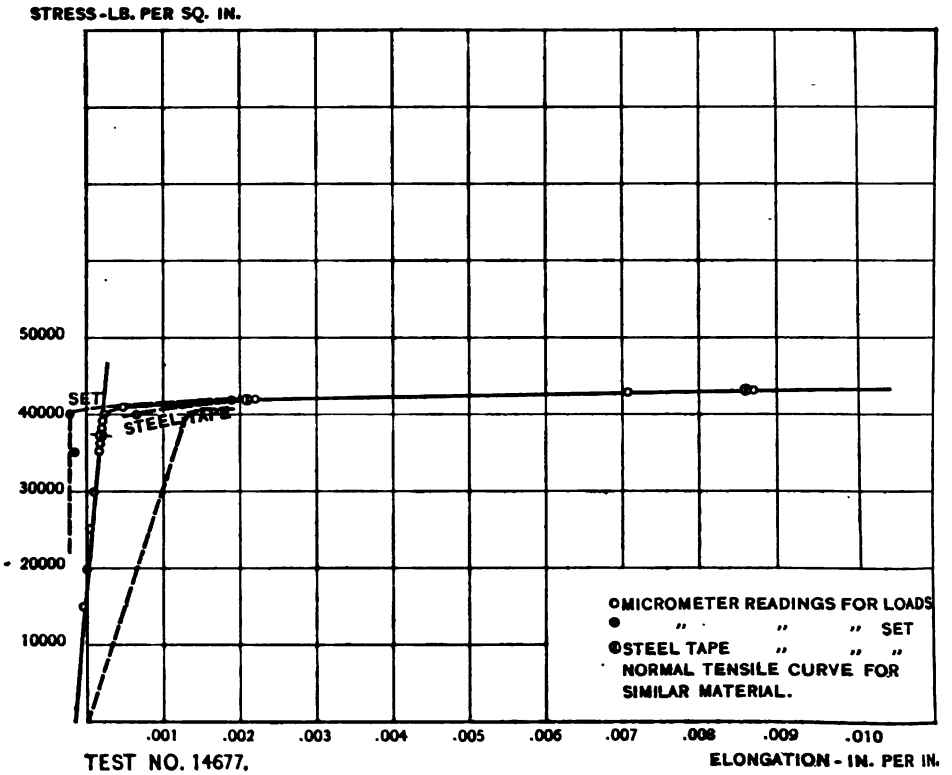
*TENSILE TEST OF COVERING RUBBER FOR WATERTOWN ARSENAL, MASS.*

Length of sample over all, 12 in. Elongation taken on gauged length of 2 in.

| Marks. | Width. | Thickness. | Sectional area. | Tensile load. | Strength, stress per square inch. | Elongation in 2 inches. | |
|---|---|---|---|---|---|---|---|
| Covering ½..... | *In.* 1.09 | *In.* 0.57 | *Sq. in.* 0.621 | *Lb.* 728 | *Lb.* 1,172 | *In.* 1.35 | *Per ct.* 67.5 |

Required: Tensile strength of not less than 600 lb. per sq. in. Elongation of not less than 75 nor more than 150 per cent.

# GUN CASTING.




TEST NO. 14677.

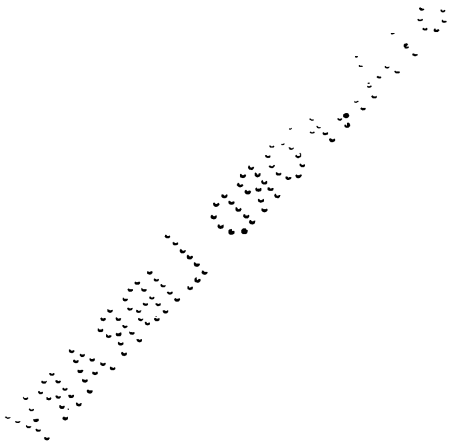
HYDROSTATIC TEST. — GUN CASTINGS.

PHOTOGRAPH NO. 1.

PHOTOGRAPH NO. 2.

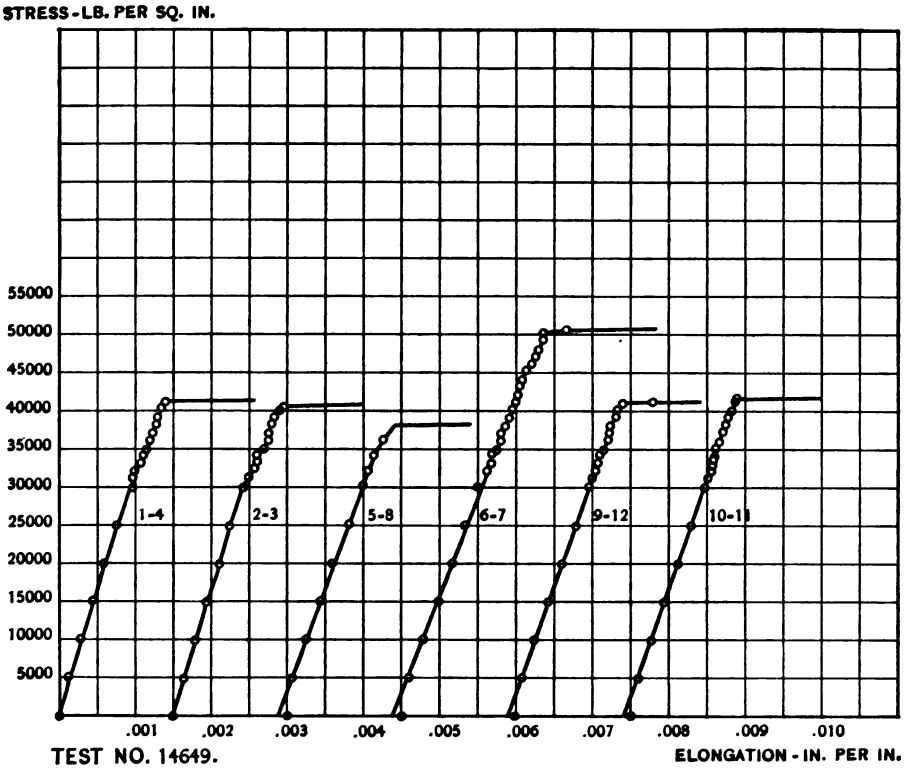
Digitized by Google

PHOTOGRAPH NO. 3.



PHOTOGRAPH NO. 4.

Approved for Release: 2019/07/22 C05100157




TENSILE TESTS OF SPECIMENS FROM GUN CASTINGS.

# BLUE AND BROWN PRINT PAPER.

## TEST 14918.

*TENSILE TESTS OF PHOTOGRAPHIC BROWN PRINT PAPER FOR THE CHIEF OF ORDNANCE, UNITED STATES ARMY, WASHINGTON, D. C., FOR THE ANNUAL SUPPLIES.*

Strips 1 inch wide were cut from the paper in the rolled direction or longitudinally. Length of samples over all, about 7 inches. Length between clamps, 3 inches.

| Marks. | Kind. | Dimensions. | | | Sectional area. | Load. | Required stress per square inch. | Stress obtained per square inch. |
|---|---|---|---|---|---|---|---|---|
| | | Width. | Required thickness (about). | Thickness obtained. | | | | |
| | | *In.* | *In.* | *In.* | *Sq. in.* | *Lb. oz.* | *Lb.* | *Lb.* |
| A | Brown | 1 | 0.003 | 0.0027 | 0.0027 | 25 2 | 7,000 | 9,300 |
| | do | 1 | .003 | .0027 | .0027 | 23 12 | 7,000 | 8,790 |
| | do | 1 | .003 | .0027 | .0027 | 26 2 | 7,000 | 9,670 |
| | do | 1 | .003 | .0027 | .0027 | 22 1 | 7,000 | 8,170 |
| B | do | 1 | .003 | .0030 | .0030 | 18 9 | 7,000 | [1] 6,180 |
| | do | 1 | .003 | .0030 | .0030 | 18 5 | 7,000 | [1] 6,100 |
| | do | 1 | .003 | .0030 | .0030 | 19 3 | 7,000 | [1] 6,390 |
| | do | 1 | .003 | .0030 | .0030 | 16 6.5 | 7,000 | [1] 5,460 |
| C | do | 1 | .003 | .0025 | .0025 | 22 2 | 7,000 | 8,850 |
| | do | 1 | .003 | .0025 | .0025 | 20 6.5 | 7,000 | 8,160 |
| | do | 1 | .003 | .0025 | .0025 | 23 | 7,000 | 9,200 |
| | do | 1 | .003 | .0025 | .0025 | 19 8 | 7,000 | 7,800 |
| D | do | 1 | .003 | .0023 | .0023 | 16 1 | 7,000 | [1] 6,980 |
| | do | 1 | .003 | .0023 | .0023 | 14 10.5 | 7,000 | [1] 6,370 |
| | do | 1 | .003 | .0023 | .0023 | 15 15.5 | 7,000 | [1] 6,930 |
| | do | 1 | .003 | .0023 | .0023 | 15 1 | 7,000 | [1] 6,540 |
| E | do | 1 | .003 | .0033 | .0033 | 19 | 7,000 | [1] 5,750 |
| | do | 1 | .003 | .0033 | .0033 | 22 5.5 | 7,000 | [1] 6,770 |
| | do | 1 | .003 | .0033 | .0033 | 21 13.5 | 7,000 | [1] 6,610 |
| | do | 1 | .003 | .0033 | .0033 | 19 3.5 | 7,000 | [1] 5,820 |
| F | do | 1 | .003 | .0031 | .0031 | 27 9 | 7,000 | 8,890 |
| | do | 1 | .003 | .0031 | .0031 | 26 1.5 | 7,000 | 8,410 |
| | do | 1 | .003 | .0031 | .0031 | 25 10.5 | 7,000 | 8,270 |
| | do | 1 | .003 | .0031 | .0031 | 26 2 | 7,000 | 8,420 |
| F 1 | do | 1 | .003 | .0030 | .0030 | 28 7 | 7,000 | 9,470 |
| | do | 1 | .003 | .0030 | .0030 | 27 8.5 | 7,000 | 9,170 |
| | do | 1 | .003 | .0030 | .0030 | 26 7 | 7,000 | 8,810 |
| | do | 1 | .003 | .0030 | .0030 | 24 7 | 7,000 | 8,140 |
| G | do | 1 | .003 | .0036 | .0036 | 17 15 | 7,000 | [1] 4,980 |
| | do | 1 | .003 | .0036 | .0036 | 19 3.5 | 7,000 | [1] 5,330 |
| | do | 1 | .003 | .0036 | .0036 | 20 4 | 7,000 | [1] 5,620 |
| | do | 1 | .003 | .0036 | .0036 | 18 14 | 7,000 | [1] 5,240 |
| H | do | 1 | .003 | .0047 | .0047 | 26 3.5 | 7,000 | [1] 5,570 |
| | do | 1 | .003 | .0047 | .0047 | 25 3 | 7,000 | [1] 5,350 |
| | do | 1 | .003 | .0047 | .0047 | 25 3.5 | 7,000 | [1] 5,360 |
| | do | 1 | .003 | .0047 | .0047 | 26 6 | 7,000 | [1] 5,610 |
| I | do | 1 | .003 | .0027 | .0027 | 21 14 | 7,000 | 8,110 |
| | do | 1 | .003 | .0027 | .0027 | 23 1 | 7,000 | 8,540 |
| | do | 1 | .003 | .0027 | .0027 | 23 1 | 7,000 | 8,540 |
| | do | 1 | .003 | .0027 | .0027 | 21 10 | 7,000 | 8,000 |

[1] Does not comply with the specifications.

### SPECIFICATIONS.

The brown print paper shall be about 0.003 of an inch thick, and possess a tensile strength of not less than 7,000 lb. per sq. in. of section, the sample to be 1 in. wide by 3 in. long, full length, and to be cut longitudinally out of the paper, the paper to be dry when tested.

## TEST 14941.

*TENSILE TESTS OF BLUE-PRINT PAPER MADE FOR THE ORDNANCE OFFICE, UNITED STATES ARMY.*

| Marks. | Dimensions. | | | Sectional area. | Load. | Required stress per square inch. | Stress obtained per square inch. |
|---|---|---|---|---|---|---|---|
| | Width. | Required thickness. | Thickness obtained. | | | | |
| | *In.* | *In.* | *In.* | *Sq. in.* | *Lb. oz.* | *Lb.* | *Lb.* |
| A | 1 | 0.0042 | 0.0054 | 0.0054 | 22 1.5 | 5,000 | 4,080 |
| | 1 | .0042 | .0054 | .0054 | 25 2.5 | 5,000 | 4,650 |
| | 1 | .0042 | .0054 | .0054 | 25 7.5 | 5,000 | 4,710 |
| | 1 | .0042 | .0054 | .0054 | 24 12.0 | 5,000 | 4,580 |
| Average | | | | | | | [1] 4,505 |
| B | 1 | .0042 | .0045 | .0045 | 28 1.5 | 5,000 | 6,230 |
| | 1 | .0042 | .0045 | .0045 | 25 11.5 | 5,000 | 5,710 |
| | 1 | .0042 | .0045 | .0045 | 28 15.0 | 5,000 | 6,420 |
| | 1 | .0042 | .0045 | .0045 | 29 8.0 | 5,000 | 6,550 |
| Average | | | | | | | 6,228 |
| C | 1 | .0042 | .0045 | .0045 | 22 8.0 | 5,000 | 5,000 |
| | 1 | .0042 | .0045 | .0045 | 21 7.5 | 5,000 | 4,760 |
| | 1 | .0042 | .0045 | .0045 | 21 6.0 | 5,000 | 4,740 |
| | 1 | .0042 | .0045 | .0045 | 23 14.0 | 5,000 | 5,300 |
| Average | | | | | | | [1] 4,950 |
| D | 1 | .0042 | .0040 | .0040 | 28 4.0 | 5,000 | 7,050 |
| | 1 | .0042 | .0040 | .0040 | 23 14.5 | 5,000 | 5,760 |
| | 1 | .0042 | .0040 | .0040 | 28 2.0 | 5,000 | 7,020 |
| | 1 | .0042 | .0040 | .0040 | 26 4.0 | 5,000 | 6,550 |
| Average | | | | | | | 6,595 |
| E | 1 | .0042 | .0045 | .0045 | 27 8.5 | 5,000 | 6,110 |
| | 1 | .0042 | .0045 | .0045 | 26 15.5 | 5,000 | 5,990 |
| | 1 | .0042 | .0045 | .0045 | 21 12.0 | 5,000 | 4,830 |
| | 1 | .0042 | .0045 | .0045 | 22 5.5 | 5,000 | 4,960 |
| Average | | | | | | | 5,473 |
| F | 1 | .0042 | .0048 | .0048 | 26 6.5 | 5,000 | 5,490 |
| | 1 | .0042 | .0048 | .0048 | 25 6.0 | 5,000 | 5,280 |
| | 1 | .0042 | .0048 | .0048 | 26 10.5 | 5,000 | 5,550 |
| | 1 | .0042 | .0048 | .0048 | 27 11.5 | 5,000 | 5,770 |
| Average | | | | | | | 5,523 |
| F 1 | 1 | .0042 | .0045 | .0045 | 25 10.5 | 5,000 | 5,700 |
| | 1 | .0042 | .0045 | .0045 | 23 0.5 | 5,000 | 5,180 |
| | 1 | .0042 | .0045 | .0045 | 20 11.0 | 5,000 | 4,580 |
| | 1 | .0042 | .0045 | .0045 | 21 14.5 | 5,000 | 4,860 |
| Average | | | | | | | 5,080 |
| F 2 | 1 | .0042 | .0048 | .0048 | 23 10.5 | 5,000 | 4,920 |
| | 1 | .0042 | .0048 | .0048 | 26 3.5 | 5,000 | 5,460 |
| | 1 | .0042 | .0048 | .0048 | 22 5.5 | 5,000 | 4,650 |
| | 1 | .0042 | .0048 | .0048 | 22 11.0 | 5,000 | 4,720 |
| Average | | | | | | | 4,938 |
| G | 1 | .0042 | .0050 | .0050 | 24 11.0 | 5,000 | 4,930 |
| | 1 | .0042 | .0050 | .0050 | 25 8.5 | 5,000 | 5,100 |
| | 1 | .0042 | .0050 | .0050 | 21 7.5 | 5,000 | 4,290 |
| | 1 | .0042 | .0050 | .0050 | 23 15.5 | 5,000 | 4,790 |
| Average | | | | | | | 4,778 |
| H | 1 | .0042 | .0040 | .0040 | 26 9.5 | 5,000 | 6,640 |
| | 1 | .0042 | .0040 | .0040 | 25 15.5 | 5,000 | 6,480 |
| | 1 | .0042 | .0040 | .0040 | 22 14.0 | 5,000 | 5,710 |
| | 1 | .0042 | .0040 | .0040 | 25 0. | 5,000 | 6,240 |
| Average | | | | | | | 6,268 |

[1] Does not comply with the specifications.

*Tensile tests of blue-print paper made for the Ordnance Office, United States Army*—Con.

| Marks. | Dimensions. | | | Sectional area. | Load. | Required stress per square inch. | Stress obtained per square inch. |
|---|---|---|---|---|---|---|---|
| | Width. | Required thickness. | Thickness obtained. | | | | |
| | *In.* | *In.* | *In.* | *Sq. in.* | *Lb. oz.* | *Lb.* | *Lb.* |
| H 1 | 1 | 0.0042 | 0.0048 | 0.0048 | 20 5.0 | 5,000 | 4,230 |
| | 1 | .0042 | .0048 | .0048 | 21 1.0 | 5,000 | 4,380 |
| | 1 | .0042 | .0048 | .0048 | 19 0.5 | 5,000 | 3,960 |
| | 1 | .0042 | .0048 | .0048 | 20 6.0 | 5,000 | 4,240 |
| Average | | | | | | | 4,203 |
| I | 1 | .0042 | .0046 | .0046 | 19 4.5 | 5,000 | 4,190 |
| | 1 | .0042 | .0046 | .0046 | 20 8.0 | 5,000 | 4,450 |
| | 1 | .0042 | .0046 | .0046 | 19 14.0 | 5,000 | 4,310 |
| | 1 | .0042 | .0046 | .0046 | 20 8.5 | 5,000 | 4,462 |
| Average | | | | | | | [1] 4,353 |
| I 1 | 1 | .0042 | .0046 | .0046 | 19 11.0 | 5,000 | 4,270 |
| | 1 | .0042 | .0046 | .0046 | 18 11.0 | 5,000 | 4,060 |
| | 1 | .0042 | .0046 | .0046 | 19 11.5 | 5,000 | 4,280 |
| | 1 | .0042 | .0046 | .0046 | 21 7.5 | 5,000 | 4,660 |
| Average | | | | | | | [1] 4,318 |

[1] Does not comply with the specifications.

SPECIFICATIONS.

Paper to be about 0.0042 in. thick, 1 in. wide, and 3 in. long. Cut longitudinally from roll. Tensile strength of at least 5,000 lb. per sq. in. Paper dry when tested:

## Test 14950.

*TENSILE TESTS OF BLUE AND BROWN PRINT PAPER FOR WATERTOWN ARSENAL, MASS.*

| Mark. | Width. | Thickness. | Sectional area. | Load. | Stress per square inch. | Kind. |
|---|---|---|---|---|---|---|
| | *In.* | *In.* | *Sq. in.* | *Lbs. oz.* | *Lb.* | |
| A | 1 | 0.0049 | 0.0049 | 22 12½ | 4,640 | Blue print. |
| | 1 | .0049 | .0049 | 20 3 | 4,130 | Do. |
| | 1 | .0049 | .0049 | 24 4½ | 4,950 | Do. |
| | 1 | .0049 | .0049 | 25 7 | 5,190 | Do. |
| Average | | | | | 4,728 | |
| B | 1 | .0045 | .0045 | 25 7½ | 5,650 | Do. |
| | 1 | .0045 | .0045 | 26 5 | 5,850 | Do. |
| | 1 | .0045 | .0045 | 25 9½ | 5,680 | Do. |
| | 1 | .0045 | .0045 | 25 4 | 5,610 | Do. |
| Average | | | | | 5,698 | |
| A-1 | 1 | .0031 | .0031 | 26 2 | 8,420 | Brown print. |
| | 1 | .0031 | .0031 | 28 9 | 9,210 | Do. |
| | 1 | .0031 | .0031 | 25 7 | 8,200 | Do. |
| | 1 | .0031 | .0031 | 25 9 | 8,240 | Do. |
| Average | | | | | 8,518 | |
| B-1 | 1 | .0030 | .0030 | 19 8½ | 6,500 | Do. |
| | 1 | .0030 | .0030 | 19 15½ | 6,650 | Do. |
| | 1 | .0030 | .0030 | 20 9½ | 6,860 | Do. |
| | 1 | .0030 | .0030 | 20 12½ | 6,920 | Do. |
| Average | | | | | 6,733 | |

# ANCHOR BOLTS.

## TEST 14953.

### *COLD-BENDING TESTS OF STEEL CASTINGS.*

A specimen 1 in. by one-half in. shall bend cold around a diameter 1 in. without fracture on outside of bent portion, through an angle of 120° for "soft" castings, of 90° for "medium" castings.

Marks: 4–13–12.

Bent through 52° around a diameter of 2.10 in. Developed a fracture at outside of bent portion.

Marks: 4–19–12.

Bent through 90° around a diameter of 1.86 in. Fractured the specimen at bend.

## TEST 14953.

### *TENSILE TESTS OF FOUR SAMPLES OF STEEL CASTINGS.*

[Inch section in which fracture occurred is marked thus *.]

| Marks. | Diameter. | Sectional area. | Elastic limit. | | Tensile strength. | | Elongation in 2 inches. | |
|---|---|---|---|---|---|---|---|---|
| | | | Load. | Stress per square inch. | Load. | Stress per square inch. | Inch. | Per cent. |
| | *In.* | *Sq. in.* | *Lb.* | *Lb.* | *Lb.* | *Lb.* | | |
| 4–13–12 | 0.500 | 0.196 | 6,300 | 32,100 | 11,600 | 59,100 | 0.21 | 10.5 |
| 4–13–12* | .498 | .195 | 6,300 | 32,300 | 11,600 | 59,400 | .21 | 10.5 |
| 4–19–12 | .500 | .196 | 6,200 | 31,600 | 12,400 | 63,200 | .19 | 9.5 |
| 4–19–12* | .500 | .196 | 6,300 | 32,100 | 12,500 | 63,700 | .23 | 11.5 |

| | Elongation in inch sections. | | Diameter at fracture. | Contraction of area. | Appearance of fracture. | Hardness. | |
|---|---|---|---|---|---|---|---|
| | | | | | | Shore. | Brinell. |
| | *In.* | *In.* | *In.* | *Per cent.* | | | |
| 4–13–12 | 0.14* | 0.07 | 0.46 | 15.3 | Amorphous | 19.5 | 131 |
| 4–13–12* | .13* | .08 | .46 | 14.8 | do | 19.5 | 131 |
| 4–19–12 | .08 | .11* | .47 | 11.7 | do | 20.0 | 137 |
| 4–19–12* | .10* | .13* | .47 | 11.7 | do | 20.0 | 143 |

Tested castings shall be of three classes, "hard," "medium," and "soft."

The minimum physical qualities required in each class shall be as follows:

| | Hard castings. | Medium castings. | Soft castings. |
|---|---|---|---|
| Tensile strength, pounds per sq. in | 85,000 | 70,000 | 60,000 |
| Yield point, pounds per sq. in | 38,250 | 31,500 | 27,000 |
| Elongation, per cent, in 2 in | 15.0 | 18.0 | 22.0 |
| Contraction of area, per cent | 20.0 | 25.0 | 30.0 |

The elastic limit given in these tests is the yield point of the material.

*REPORT OF STEEL ANALYSIS.*

[Steel from castings.]

| Sample. | C. | Mn. | Si. | S. | P. |
|---|---|---|---|---|---|
| *Marks.* | | | | | |
| Tension 4-13-12 | 0.24 | 0.62 | 0.265 | 0.059 | 0.045 |
| Tension 4-13-12 | .24 | .60 | .260 | .060 | .042 |
| Tension 4-19-12 | .26 | .65 | .197 | .058 | .043 |
| Tension 4-19-12 | .25 | .62 | .200 | .060 | .045 |
| Bending 4-13-12 | .24 | .63 | .262 | .060 | .045 |
| Bending 4-19-12 | .27 | .55 | .203 | .059 | .046 |

# PRIVATE TESTS.

## *PRIVATE TESTS MADE DURING THE FISCAL YEAR ENDED JUNE 30, 1912.*

| Date. | Material. | Name. | City and State. |
|---|---|---|---|
| 1911. | | | |
| July 21 | Steel | The Wyman & Gordon Co | Worcester, Mass. |
| Aug. 16 | Semisteel | The Pickering Governor Co | Portland, Conn. |
| 16 | Cord | Tucker & Carter Rope Co | New York, N. Y. |
| 26 | Concrete cubes | Henry W. Hayes | Boston, Mass. |
| 29 | Steel | Coe Brass Manufacturing Co | Ansonia, Conn. |
| Sept. 2 | Concrete building blocks. | E. Schier | Buffalo, N. Y. |
| 2 | do | James M. Roache | Arlington, Mass. |
| 2 | Swivel | Weatherly Foundry & Machine Co. | Weatherly, Pa. |
| 5 | do | do | Do. |
| 5 | Breaker links | Plymouth Cordage Co | North Plymouth, Mass. |
| 5 | Manila rope | do | Do. |
| 6 | Rubber belting | Revere Rubber Co | Chelsea, Mass. |
| 7 | Concrete cubes | City civil engineer | Dayton, Ohio. |
| 7 | Columns | Louis Miller Co. (Inc.) | East Boston, Mass. |
| 11 | Concrete cubes | H. F. Tucker | Boston, Mass. |
| 14 | do | Boston Elevated R. R. Co | Do. |
| 15 | do | H. F. Tucker | Do. |
| 18 | Breaker links | Plymouth Cordage Co | North Plymouth, Mass. |
| 18 | Steel | Lenox Motor Car Co | Jamaica Plain, Mass. |
| 18 | Concrete cubes | H. F. Tucker | Boston, Mass. |
| 20 | Columns | Joseph Miller Column Co | Cambridgeport, Mass. |
| 28 | Concrete building blocks. | Smith Bros. Concrete Co | Watertown, Mass. |
| 28 | do | J. S. Bellanca | Buffalo, N. Y. |
| 30 | Concrete cubes | H. F. Tucker | Boston, Mass. |
| Oct. 2 | Concrete building blocks. | Joseph Ryan & Sons | Buffalo, N. Y. |
| 4 | Cast iron | Richmond Iron Works | Richmond Furnace, Mass. |
| 4 | Steel wire | Stanley Motor Carriage Co | Newton, Mass. |
| 6 | Shackles and swivels | Fletcher & Crowell | Portland, Me. |
| 9 | Concrete cubes | H. F. Tucker | Boston, Mass. |
| 13 | Manila rope | Boston Elevated R. R. Co | Do. |
| 19 | Concrete cubes | do | Do. |
| 19 | Steel | Indianapolis Drop Forging Co | Indianapolis, Ind. |
| 20 | Concrete cubes | Boston Elevated R. R. Co | Boston, Mass. |
| 20 | Shackles | Fletcher & Crowell | Portland, Me. |
| 21 | Chimney brick | M. W. Kellogg Co | New York, N. Y. |
| 21 | Clay building blocks | E. B. Reed | Buffalo, N. Y. |
| 23 | Sash chain | Bridgeport Chain Co | Bridgeport, Conn. |
| 23 | Steel | The Marlin Firearms Co | New Haven, Conn. |
| 23 | do | The Pennsylvania Ry. Co | Altoona, Pa. |
| 24 | Limestone cubes | The Victoria Limestone Co | Bowling Green, Ky. |
| 24 | Bronze coupling | Coffin Valve Co | Boston, Mass. |
| Nov. 6 | Steel | Lorraine Manufacturing Co | Pawtucket, R. I. |
| 4 | do | General Electric Co | Schenectady, N. Y. |
| 7 | Concrete cubes | H. F. Tucker | Boston, Mass. |
| 7 | Concrete building blocks. | Schultz Ice Co | Buffalo, N. Y. |
| 7 | do | Alexander M. Bellony | Do. |
| 8 | Mortar cubes | H. F. Tucker | Boston, Mass. |
| 15 | Concrete cubes | Boston Elevated R. R. Co | Do. |
| 18 | Mortar cubes | H. F. Tucker | Do. |
| 21 | Concrete cubes | do | Do. |
| 21 | do | Simpson Bros. (Corp.) | Do. |
| Dec. 5 | Column | United States Column Co | Cambridge, Mass. |
| 6 | Concrete cubes | H. F. Tucker | Boston, Mass. |
| 6 | Cast stone column | Hoyt E. Fuller | Natick, Mass. |
| 7 | Concrete cubes | H. F. Tucker | Boston, Mass. |
| 7 | Rope | A. C. Lawrence Leather Co | Do. |
| 8 | Tiles | The Ohio Clay Co | Cleveland, Ohio. |
| 9 | Rubber belting | Revere Rubber Co | Chelsea, Mass. |
| 9 | Steel | J. W. Mitchell | Boston, Mass. |
| 9 | Concrete cubes | H. F. Tucker | Do. |
| 12 | Draft gears | Standard Coupler Co | New York, N. Y. |
| 12 | do | do | Do. |
| 26 | Swivel and shackle | Weatherly Foundry & Machine Co. | Weatherly, Pa. |
| 29 | Steel | Edward A. Tucker (Inc.) | Boston, Mass. |

*Private tests made during the fiscal year ended June 30, 1912*—Continued.

| Date. | Material. | Name. | City and State. |
|---|---|---|---|
| 1912. | | | |
| Jan. 8 | Steel | New York Air Brake Co | Watertown, N. Y. |
| 8 | Steel rollers | American Steel & Wire Co | Worcester, Mass. |
| 9 | Swivel | Fletcher & Crowell | Portland, Me. |
| 12 | Steel plate | Stanley Motor Carriage Co | Newton, Mass. |
| 16 | Rope | Rinek Cordage Co | Easton, Pa. |
| 19 | Steel music wire | National Piano Co | Boston, Mass. |
| 23 | Eyebars | Long Island R. R. Co | Jamaica, N. Y. |
| 26 | Steel | Lenox Motor Car Co | Boston, Mass. |
| 30 | ....do | ....do | Do. |
| 30 | Iron | Dr. Chas. F. McKenna | New York, N. Y. |
| Feb. 1 | Eyebar | Long Island R. R. Co | Jamaica, N. Y. |
| 2 | Aluminum and bronze | Non Corrosive Metal Manufacturing Co. | Watertown, Mass. |
| 7 | Shackle | Fletcher & Crowell | Portland, Me. |
| 14 | Steel | J. W. Mitchell | Boston, Mass. |
| 17 | Concrete building blocks. | Ralph Silvestro | Medford, Mass. |
| 21 | Steel links | The Thomas Laughlin Co | Portland, Me. |
| 21 | Column | Daniel Buckley | Dorchester, Mass. |
| 23 | Canvas belt | Fire Fighters Fearnaught Belt Co. | Boston, Mass. |
| 24 | Steel | Erie Forge Co | Erie, Pa. |
| Mar. 6 | Stone | Columbia Finance Co | Spokane, Wash. |
| 7 | Monel metal | The Bayonne Casting Co | Bayonne, N. J. |
| 8 | ....do | ....do | Do. |
| 8 | Steel | Bethlehem Steel Co | South Bethlehem, Pa. |
| 11 | Buffer springs | Standard Coupler Co | New York, N. Y. |
| 15 | Steel | Pennsylvania R. R. Co | Altoona, Pa. |
| 16 | Concrete building blocks. | Zoel A. Houle | Watertown, Mass. |
| 20 | Buoy swivel | Weatherly Foundry & Machine Co. | Weatherly, Pa. |
| 20 | Bolt | Dr. Chas. F. McKenna | New York, N. Y. |
| 23 | Riveted joints | Board of Water Supply | Do. |
| 25 | Rubber belting | Revere Rubber Co | Chelsea, Mass. |
| 25 | Conveyer belt | ....do | Do. |
| 26 | Shackles | Fletcher & Crowell Co | Portland, Me. |
| 27 | Stone | The Connecticut Crushed Stone Co. | Hartford, Conn. |
| 27 | Concrete cubes | H. F. Tucker | Boston, Mass. |
| 30 | ....do | Boston Elevated R. R. Co | Do. |
| Apr. 1 | ....do | ....do | Do. |
| 1 | Manila rope | Plymouth Cordage Co | North Plymouth, Mass. |
| 3 | Belting | Revere Rubber Co | Chelsea, Mass. |
| 3 | Steel | Crucible Steel Co | Pittsburgh, Pa. |
| 6 | Cast iron | Davis & Farnum Manufacturing Co. | Waltham, Mass. |
| 9 | Steel balls | Metz Co | Do. |
| 11 | Conveyer belt | Revere Rubber Co | Chelsea, Mass. |
| 12 | Shackles | Fletcher & Crowell Co | Portland, Me. |
| 16 | Concrete cube | Boston Elevated R. R. Co | Boston, Mass. |
| 20 | Manila rope | Rinek Cordage Co | Easton, Pa. |
| 23 | Swivel | Weatherly Foundry & Machine Co. | Weatherly, Pa. |
| 23 | Concrete cube | Boston Elevated R. R. Co | Boston, Mass. |
| 30 | ....do | H. F. Tucker | Do. |
| May 8 | Shelf supports | The Snead & Co. Iron Works | Jersey City, N. J. |
| 10 | Swivel | Treadwell Engineering Co | Easton, Pa. |
| 16 | Sash chain | The Bridgeport Chain Co | Bridgeport, Conn. |
| 18 | Swivels | Treadwell Engineering Co | Easton, Pa. |
| 20 | Brick | New England Brick Co | Boston, Mass. |
| 23 | Crucible steel casting | Connolly Steel Casting Co | Chelsea, Mass. |
| June 4 | Track bolts | The Pennsylvania Steel Co | Boston, Mass. |
| 10 | Concrete building block. | H. S. Hemingway | Somerville, Mass. |
| 11 | Shelf supports | The Snead & Co. Iron Works | Jersey City, N. J. |
| 12 | Bricks | Bay State Brick & Stone Co | Springfield, Mass. |
| 13 | Steel | The Pennsylvania Steel Co | Steelton, Pa. |
| 14 | ....do | ....do | Do. |
| 15 | Shackles | Fletcher & Crowell | Portland, Me. |
| 15 | Steel | Titusville Forge Co | Titusville, Pa. |
| 17 | ....do | Builders Iron Foundry | Providence, R. I. |
| 19 | Swivel | Treadwell Engineering Co | Easton, Pa. |
| 21 | Sash chain | The Bridgeport Chain Co | Bridgeport, Conn. |
| 26 | Sand-lime bricks | Bay State Brick & Stone Co | Springfield, Mass. |
| 26 | Concrete building block. | H. S. Hemingway | Somerville, Mass. |
| 26 | ....do | Theo. Kaitanowski | Buffalo, N. Y. |
| 27 | Rubber belting | Revere Rubber Co | Chelsea, Mass. |

# INDEX.


| | Page. |
|---|---|
| Analysis, chemical: | |
| Cast steel from Watertown Arsenal foundry | 125–141 |
| Equalizing pipe, 12-inch, M. C., model of 1896M1 | 220 |
| Anchor bolts, tensile and bending tests of specimens from mortar carriages | 237 |
| Balls, steel, compressive tests of | 177 |
| Bevel gear blank for 14-inch gun turret, hardness test of | 177 |
| Blue and brown print paper, tensile tests of | 233–236 |
| Bolts, anchor, tensile and bending tests of specimens from | 237 |
| Brass, tensile test of seamless tube of | 176 |
| Bridles: | |
| Marline covered wire rope, tensile test of | 208, 212–218 |
| Manila rope, tensile test of | 209–211 |
| Bronze from Watertown Arsenal foundry, tensile tests of | 157–163 |
| Buffer springs, compressive tests of | 111, 115–116 |
| Cast iron from Watertown Arsenal foundry, tensile tests of | 165–168 |
| Cast steel from Watertown Arsenal foundry, tensile tests of | 125–141 |
| Chain, proof stresses applied to: | |
| Crane, $\frac{3}{4}$-inch | 174 |
| Steel, $\frac{3}{4}$-inch | 174 |
| Columns, steel-built I, compressive tests of | 85–106 |
| Comparison of testing machines, tensile tests of specimens for: | |
| Builders iron foundry | 194 |
| Bethlehem Steel Co. | 185 |
| Crucible Steel Co. of America | 192 |
| Inspector of ordnance, United States Navy, South Bethlehem, Pa. | 186–191 |
| Springfield Armory | 184 |
| Titusville Forge Co. | 193 |
| Cordage, tensile tests, manila rope for Watertown Arsenal | 195–205 |
| Crosshead pawl springs, 10-inch, D. C., L. F., model of 1901, tensile tests of | 117 |
| Counter-recoil springs, 12-inch, M. C., model of 1896M1, compressive tests of | 122–123 |
| Elevating screws, Nos. 1, 3, 4, and 5, metallographic examinations of | 221 |
| Equalizing pipe, 12-inch, M. C., model of 1896M1, No. 164, metallographic examination of | 220 |
| Extractor, steel, metallographic examination of | 220 |
| Forged steel, tensile tests of: | |
| From Watertown Arsenal smith shop | 143–152 |
| Experiments for student officers | 153–154 |
| Friction test of 7-ply pneumatic hose | 176 |
| Gun, hydrostatic test of casting from | 227–231 |
| Gun and tool steel from Watertown Arsenal smith shop, tensile tests | 169–170 |
| Hollow-deck stanchions, 5-inch, for New York Navy Yard, tensile test | 182 |
| Hose, 7-ply, $\frac{1}{2}$-inch pneumatic, tube and friction tests of | 176 |
| Insulator, strain, tensile test of | 177 |
| Iron. (*See* Cast iron.) | |
| Manila rope, tensile tests of | 195–205 |
| Metallographic examinations of: | |
| Collar of elevating screw No. 1, 14-inch, D. C., L. F., model of 1907 | 221 |
| Elevating screws, Nos. 3, 4, and 5 | 221 |
| Equalizing pipe, 12-inch, M. C., model of 1896M1, No. 164 | 220 |
| Extractor, steel, 15-pounder gun, model of 1903 | 220 |
| Nut, fractured | 220 |
| Steel specimen marked "6684—330A" | 221 |
| Paper, tensile tests of blue and brown print | 233–236 |

Page.
Pawl and rack of 14-inch, D. C., model of 1907, strength of teeth of..... 178–180
Pipe, equalizing, 12-inch, M. C., model of 1896M1, metallographic examination of..... 220
Piston rods, proof stresses applied to:
15-pounder..... 172
14-inch gun turret mounts, model of 1909..... 173
12-inch, M. C., model of 1908..... 173
12-inch, M. C., model of 1908, pilot R. & L..... 172
Private tests..... 244–245
Rack and pawl of 14-inch, D. C., model of 1907, strength of teeth of..... 178–180
Rope:
Manila, tensile tests of..... 195–205
Steel wire, tensile tests of..... 205–207
Rubber, tests for Watertown Arsenal..... 223–226
Screws, elevating, metallographic examination of..... 221
Square steel wire for winding guns, tensile tests of..... 11–44
Springs for ordnance work:
Buffer—
8-inch ammunition truck, compressive test of..... 111
12-inch, D. C., model of 1896, compressive test of..... 115
14-inch, D. C., L. F., model of 1907, compressive test..... 116
Counter recoil, 12-inch, M. C., model of 1896M1, inner spring, compressive test..... 122–123
Crosshead pawl, 10-inch, D. C., L. F., model 1901, tensile test..... 117
Elevating slide, 6-inch, D. C., model of 1905, compressive test..... 114
Friction, for 15-pounder, B. C., model of 1903, compressive test..... 113
Helical, compressive test of..... 108
Latch, compressive test of..... 112
Outer and inner, 6-inch, B. C., model of 1910, compressive test..... 118
Pawl safety latch, 8-inch, D. C., model of 1896..... 109
Pawl, received from Sandy Hook Proving Ground, for 14-inch, D. C., model of 1897..... 110
4.72 dummy projectile, compressive test of..... 119
6-inch dummy projectile, compressive test of..... 120
10-inch dummy projectile, compressive test of..... 121
Stanchions, 5-inch, hollow-deck, for New York Navy Yard, tensile test..... 182
Steel balls, compressive test of..... 177
Steel-built I columns, compressive test of..... 85–106
Steel castings for ordnance work, tensile tests of..... 125–141
Steel castings, cold bending tests of..... 240
Steel castings, open-hearth furnace, specimens, tensile tests of..... 140–141
Steel extractor, 15-pounder, gun, model of 1903, metallographic examination of..... 220
Steel forgings for ordnance work, tensile tests of..... 143–152
Steel forgings, experiments for student officers..... 153–154
Steel, gun and tool, from Watertown Arsenal smith shop, tensile tests..... 169–170
Steel specimens taken from broken rail from track in yard of Watertown Arsenal, tensile tests of..... 178
Steel wire rope, tensile tests of..... 205–207
Strain insulator, compressive test of..... 177
Teeth in pawl and rack of 14-inch, D. C., model of 1907, strength of..... 178–180
Tool and gun steel from Watertown Arsenal smith shop, tensile tests..... 169–170
Tube and friction tests of 7-ply, ½-inch pneumatic hose..... 176
Tube, seamless brass, tensile test of..... 176
Wire, bridles, marline covered rope, tensile tests of..... 208
Wire, square steel, for winding guns, tensile tests of..... 11–44

○

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